DIMENSIONS NBS

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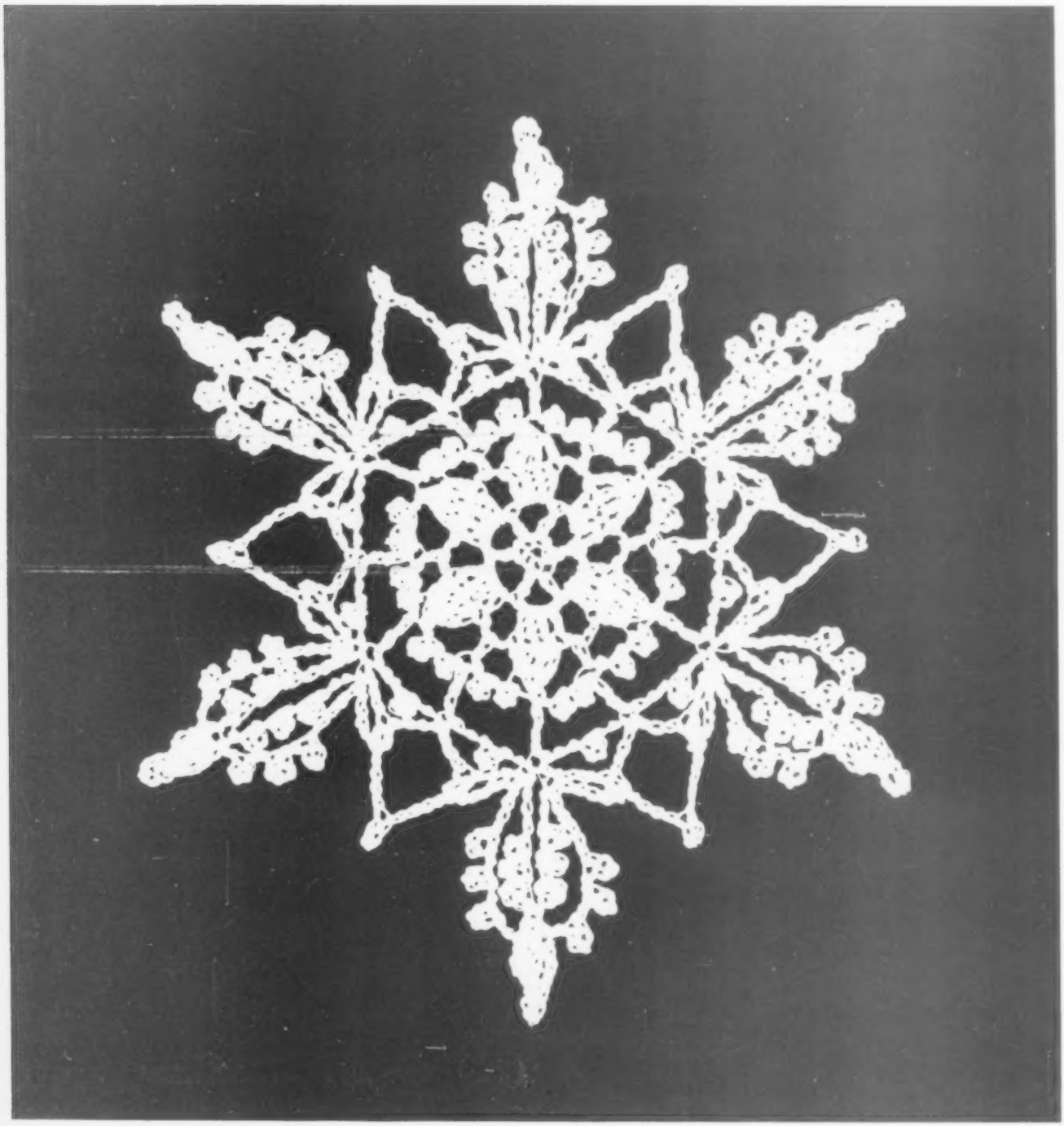


WINTER SAVINGS. See page 2.

COMMENT

A VIEW FROM BOULDER

A new and challenging era is beginning for the National Bureau of Standards' Boulder laboratories. During Congressional oversight hearings last October, NBS acting director Ernest Ambler mentioned plans for reorganizing all of NBS.* With the reorganization, Boulder would move into a structure that includes elements of the planned National Measurement Laboratory and the planned National Engineering Laboratory. There would be a redefined role for the Director of the Boulder laboratories.

The Institute for Basic Standards-Boulder era, which began in 1968, has been one of notable accomplishment, and I will touch on some of those accomplishments later. The unified IBS management structure supported the Boulder Laboratories at a time of growing maturity for both the personnel and the programs.

Just as the IBS umbrella was placed over Boulder to meet certain needs, so the new structure is being initiated to provide more program coherence. The concept of shared authorities, whereby the director of the Boulder Laboratories will work with the directors of the NML and NEL on program, personnel, and administrative matters, is an exciting and challenging one. I will dedicate myself to insuring that this concept works—both for the betterment of the new NBS and for the personal fulfillment of the many scientists, engineers, and support personnel who have devoted themselves to the Boulder labs.

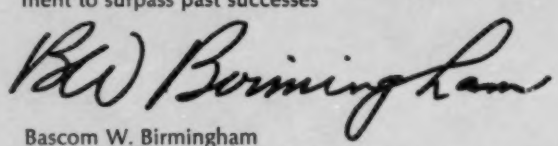
It is appropriate at this time, I believe, to look back over the past 10 years and examine the base upon which the future of the Boulder labs rests. During this period, the Cryogenics Division, which traces its Boulder origins to 1951, became perhaps the most respected cryogenics research facility in the country. I would like to note just two important cryogenic programs initiated under IBS leadership. The Division's flow measurement expertise was applied to the problems of measuring liquefied natural gas. Because of this Division's foresight, the United States will be in good shape when LNG becomes an important source of energy supplies, probably in the mid-1980's. At the same time, an entirely new area of research was begun with creation of the Cryoelectronics Section. This program promises to build new avenues of technology transfer by applying superconducting electronic systems to a broad range of measurement problems and standards. We are employing these systems in new electromagnetic field measurements. Sensitive magnetometry useful in prospecting for geothermal energy sources and mineral deposits is one of the exciting prospects in this area.

Development of NBS-6, the latest generation of atomic clocks that is accurate to one second in 370,000 years, and the frequency synthesis work that achieved the highest frequency measurement to date (and a place in the Guinness Book of World Records), are two of the highlights of the Time and Frequency Division under IBS management.

In the Electromagnetics Division, one of the notable achievements has been the development of a technique for taking antenna measurements in the near-field and extrapolating them accurately to the far-field. The result has been reduced costs to industry and government for antenna measurements and, in most cases, more complete data than could be obtained from far-field measurements.

A most important milestone in the Joint Institute for Laboratory Astrophysics was the development of the methane-stabilized laser. This technique has had a profound impact on laser metrology. It may enable lasers to provide the world's standard of length, being one thousand times more reproducible and stable than the wavelength of the orange-red line of krypton-86 light, the present standard of length. Stabilized lasers have allowed a new value for the speed of light to be obtained, one that is 100 times more accurate than the previous value.

These and many other accomplishments over the past decade have been the fruits of dedicated scientists. This spirit survives and will be nurtured with renewed vigor under the new organization structure. We are at a point where the last chapter has been written on the old order and pen has just been taken in hand to record the new. We will strive to make that record even more meaningful and productive than the old. And, as Boulder prepares to celebrate its 25th anniversary this year, I can think of no more fitting tribute than a sincere commitment to surpass past successes



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* See page 10 for Ambler's remarks.

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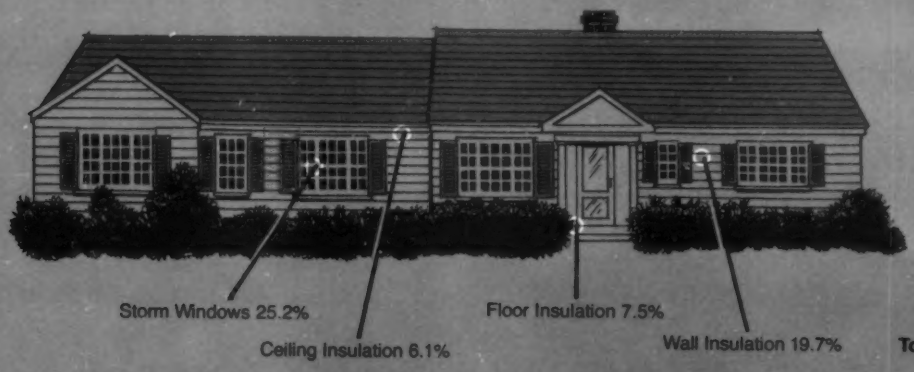

TEST HOME at Gaithersburg, Md., where *National Bureau of Standards* saved heating fuel in amounts shown.

It's Never Too Late to INSULATE!

by Madeleine Jacobs

When it's cold enough to snow, the cost of heating an uninsulated or poorly insulated house begins to soar. Yet at least one public opinion survey* indicates that half the people in the United States do not believe that adding insulation will help save energy.

A new study from the National Bureau of Standards should go far in changing the minds of the disbelievers. The study, carried out on a poorly insulated wood frame house near Washington, D.C., showed that adding insulation and storm windows can reduce heating energy use by more than 50 percent. Specifically, the use of storm windows cut heating energy requirements by 25.2 percent in the test home. Insulation in the walls, ceiling, and floor dropped energy consumption by an additional 33.3 percent during the winter months—tor a total energy savings of 58.5 percent.

Not all homeowners can expect to duplicate these exact results. Reductions will depend on the original condition of the house and how much insulation is added. But there's no question that energy conservation measures do reduce energy requirements —and that means dollar savings on heating bills. ing bills.

The two-year study** on how much energy can be saved by installing energy conservation measures (retrofitting) in a house was carried out by engineers Douglas Burch and Charles Maxwell Hunt of the NBS Center for Building Technology. The research was funded by the Federal Energy Administration, which is now part of the Department of Energy.

Many figures have been cited in the news media on the potential savings from retrofitting, but most of these figures are calculated estimates which are based on many assumptions. Prior to the NBS study, very few tests had been performed to measure precisely the energy reductions achievable from retrofitting. Engineer Burch explains that the major objective of the study was to learn exactly how much energy could be saved in both winter and summer by retrofitting a house that had limited insulation. "In addition, we were interested in determining the effectiveness of certain 'recommended good practices' for preventing damage from moisture accumulation in attics and crawlspaces," he states.

Fortunately, Burch did not have far to look to find an ideal test house. Situated on a wooded corner of the Gaithersburg campus of NBS is a 25-year-old wood frame house. Called the Bowman House by NBS researchers (after the family who once lived there), the building is used for studies of energy conservation and consumer products.

The Bowman House was built in the early 1950's. The house has a floor area of 192 square meters, excluding the unheated basement floor area. This makes it considerably larger than average houses in the United States, which range from about 100 to 140 square meters in floor space. Typical of homes built during an era of cheap energy, the Bowman House was poorly insulated. The walls and floor had no thermal insulation. The attic floor had glass fiber blanket insulation having an R value of about 11 laid on top of the ceiling between the joists. (The R, or resistance, value of insulation is a measure of its ability to decrease heat flow. The higher the R value, the more effective the insulation in saving energy.) An asphalt-impregnated kraft

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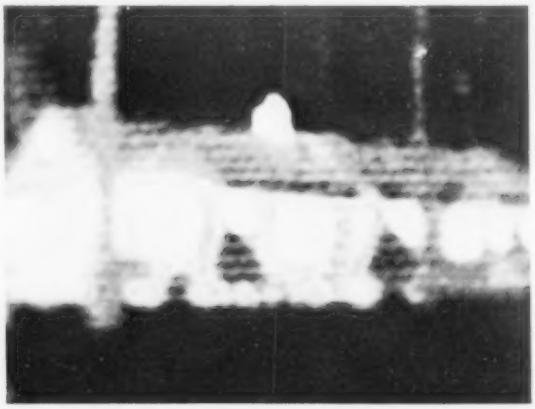
*"How Consumers Feel About Energy: Attitudes and Behavior During the Winter and Spring of 1976-1977," J. S. Milstein, Federal Energy Administration, June 1977.

Jacobs is a writer and public information specialist in the NBS Office of Information Activities.

**"Retrofitting an Existing Wood Frame Residence for Energy Conservation—An Experimental Study," by D. M. Burch and C. M. Hunt. Available for $6.75 a copy from the National Technical Information Service, Springfield, VA 22151. Use NTIS No. PB 269-847 when ordering.

COVER STORY



paper vapor barrier was present on the backside of the insulation so that it faced the ceiling below.

The house initially had single pane windows except for a large picture window in the living room which contained insulating glass. The window area was 16 percent of the wall area and 11 percent of the floor area, about average for most houses.

"An interesting feature of this house," Burch says, "was that good weather stripping had been installed around the doors and windows. The general construction of the house was tight and the quality of construction indicated that the home had been built by skilled carpenters."

Burch and Hunt carried out measurements in several steps. First, they measured winter heating energy requirements on the house in its original state, equipped with an oil-fired forced air furnace. Next, they measured pre-retrofit summer cooling energy consumption during summer conditions.

After the winter and summer tests were completed, the house was retrofitted in three stages. Stage 1 involved the reduction of air leaks. NBS engineer Max Hunt was able to provide special expertise, as he had designed semi-automated equipment for measuring air infiltration in buildings.

"As a result of these tests, we took certain specific measures to seal air leaks," Burch explains. "For example, smoke tests indicated that air was leaking from the fireplace and from the kitchen exhaust fan. We repaired the fireplace damper and replaced the kitchen ventilation exhaust fan with one that had a spring-activated damper. We put putty around window panes and recaulked window frames where it was needed. We also installed improved weather stripping under exterior doors. All of these things could be performed easily by a homeowner."

In addition to the smoke tests, a technique called infrared thermography* was used to reveal air leaks. These studies showed, among other things, that heat was leaking from a crack between the exterior siding and the foundation wall. As a result of this finding, a board was inserted into the crack, followed by application of a caulking compound. Thermograms taken after retrofit were useful in revealing defects in the insulation installation.

In Stage 2, storm windows were added to the house. Insulating the house was the third stage of the study. Glass fiber insulation with an R value of about 18 was installed under the floor over the crawlspace. R-21 cellulose insulation was blown on top of existing glass fiber blankets in the attic, bringing it up to about R-32. Three types of wall insulation were installed. Fibrous glass wool was blown into one 4.3-meter wall section of the house, and urea-formaldehyde foam was installed in an equally sized wall section. The remainder of the walls in the test house were insulated with cellulose.

After each of these stages of the retrofit, winter energy measurements were performed permitting the energy savings achieved by each stage to be determined. During the following summer, cooling energy measurements were made on the retrofitted house. For both winter and summer measurements, a variety of information was collected, including data on energy consumption, indoor temperature, and outdoor weather factors (such as solar radiation on the roof of the house).

"When the winter heating energy savings were calculated, we did not find any measurable energy savings resulting from sealing air leaks," Burch says. "This was because the house was tightly constructed. In the leaky houses that have no weather stripping or caulking, it will pay homeowners to seal air leaks."

The total heating energy savings achieved from

*Infrared thermography is based on the principle that all surfaces emit energy in the form of electromagnetic radiation. An infrared television system is used to detect surface temperatures of buildings such as the Bowman House. This system includes an infrared (IR) TV camera, a black and white TV monitor, a color TV monitor, and a temperature profile display monitor. Upon sensing the radiation emitted from a surface, the IR camera produces a video signal. The video signal is processed in the black and white TV monitor where it is converted into a thermal picture in which the gray tones in the picture approximately correspond to surface temperatures. A photograph of the thermal picture is called a thermogram. Video signals are also fed into the color TV monitor. A thermal picture is produced in which the temperature range has been divided into ten regions, each coded with a separate color. In the color-coded thermogram, black is the coldest region and white is the warmest region.

The thermogram on the opposite page was taken before the Bowman House was retrofitted. Light areas show that heat is leaking from the walls and windows. Thermogram taken after retrofitting shows that the house is now well insulated.

installing storm windows and insulation was 58.5 percent. Insulation accounted for 33.3 percent, of which the engineers calculated that 19.7 percent came from wall insulation, 6.1 percent from attic insulation, and 7.5 percent from floor insulation. "If the attic had been uninsulated in the beginning, the savings from adding attic insulation would have been much greater," Burch notes.

The dramatic energy savings of the winter were not repeated in the summer. There were a number of reasons for this result, according to Burch. For one thing, the windows were not opened at night to take advantage of the natural cooling of the house with cool night air. The extra insulation in the walls and the storm windows were actually trapping heat inside the house at night which had to be removed mechanically by the air conditioning. In addition, the insulation placed in the floor over the crawlspace prevented much of the natural cooling that is provided by heat loss through the floor. This effect more than offset the benefits derived from additional ceiling insulation.

"Energy savings in the summer might have been achieved if the house were located in a climate where the average indoor-outdoor temperature difference is large," Burch concludes. He adds that the benefit of insulating the floor over a crawlspace should be evaluated over a year since the winter benefits of floor insulation are likely to be partially offset by reduced heat loss to the crawlspace during the summer.

An economic analysis also was carried out to evaluate the cost effectiveness of the various stages of the retrofit. This analysis was based in part on the costs of the retrofit and assumed efficiencies for different types of heating plants (oil, gas, electric, and heat pumps). The analysis showed that payback periods for having storm windows installed ranged from 5.4 to 10.2 years, depending on the type of heating plant. Payback periods for having insulation installed in the walls, ceiling, and floor ranged from 9.5 to 17.5 years, again depending on the type of heating plant.

Burch notes that energy savings and payback periods depend on the efficiency of the furnace, the cost of fuel, the climate, the structure of the house, and many other factors. For example, the more expensive the fuel, the larger the dollar savings. Or, if the test home had been located where winters are much colder, the payback periods would have been considerably shorter. For this particular test house, costs would be recovered more quickly for storm windows than for insulation, but that might not always be the case.

Standard practices for reducing moisture accumulation in attics and crawlspaces were also examined. Moisture accumulation in attics can be a serious problem in locations where winters are cold. In the winter, activities inside a residence—such as doing laundry, taking showers, and cooking—can release as much as 11 kg of water vapor per day. Some of this water vapor will escape through or around the ceiling and condense on cold roof surfaces. Later the condensation may drip onto the attic floor and wet the insulation. Then, when warm weather comes, if wood members in the attic are not able to give up the moisture, fungus may attack the wood.

When the attic insulation was installed in the Bowman House, ventilation openings were provided in the amount of 0.1 square meter for every 30 square meters of attic floor area. Also, the existing ceiling insulation was equipped with a vapor barrier facing downward. The combination of these two protective measures was effective in keeping the attic dry during the winter, according to Burch.

Similarly, a vapor barrier ground cover was placed over the bare earth of the crawlspace and crawlspace ventilation openings were provided. These protective measures were found to be effective in keeping the summer moisture content of the wood parts of the floor at a satisfactory level.

The Bowman House study is a convincing demonstration that energy and money can be saved by retrofitting a house. Many new homes have begun to incorporate energy saving features, but new construction still accounts for only a small percentage of existing housing.

Says Burch, "Although an initial expenditure is required, retrofitting provides a sensible and effective technique for the homeowner to save energy and reduce fuel costs." □

Perspectives on NBS

A subcommittee of the Congress heard testimony last October 25 concerning the programs, goals, problems, and prospects of the National Bureau of Standards. The occasion was a day of NBS oversight hearings conducted by the Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology. Such hearings are held by both houses of the Congress—at their discretion—to aid the legislature in overseeing the work of agencies in the Executive Branch of the federal government.

It appears that NBS is at a turning point in its 76-year "career" as the nation's physical science and measurement laboratory. This, at least, was one theme that ran through the testimonies offered by the four individuals who spoke before the subcommittee. As a service to the readers of DIMENSIONS/NBS, what was reported to the members of the House subcommittee is presented on the following pages. Each individual who testified has been closely associated with the activities of the Bureau, but each also speaks from and reflects a different perspective.

BARUCH—

The Future of NBS

Dr. Jordan J. Baruch is the Commerce Department's Assistant Secretary for Science and Technology. As such, he plays a role in shaping the policies and programs of the National Bureau of Standards. Although he has held this position for less than a year, he has been associated with the National Bureau of Standards for many years, serving as an advisor on NBS facilities and programs through the evaluation panels appointed by the National Academy of Sciences-National Research Council.

MR. Chairman and Members of the Subcommittee, let me express my appreciation for being permitted to express my views on the National Bureau of Standards. Despite the fact that that opening sentence is often pro forma for testimony, in this case it is said with special sincerity. All during my training as an engineer—and especially during my doctoral training in instrumentation—NBS had a special meaning for me. Now to share in determining its future course is, for me, both a special opportunity and a deeply felt responsibility.

To exercise that responsibility, however, requires that I first set the Bureau in context, a context made up of national and international scientific, technological, and economic realities.

NBS is in many ways a unique institution. It has a broad range of competence—in basic measurements, materials, buildings, and computers, to name just a few. It has had a worldwide reputation for excellence and for objectivity. Dr. Ernest Ambler will review with you our concern that the present level of basic scientific competence at NBS may be insufficient to meet future demands. Suffice to say that the Administration is cognizant that this problem may exist and will be considering remedies.

"The Bureau has also had long history of problem solving and wide ranging assistance to American industry."

The Bureau has also had a long history of problem solving and wide ranging assistance to American industry. In fact, if industry has any complaint about the Bureau, it is that NBS is spread too thin.

But what is it that NBS really does? While Dr. Ambler will speak directly to this point in some detail, let me give a broad brush treatment. NBS provides this nation with the measurement know-how that is so vital to science, technology, and commerce; know-how that provides the basis for probing and understanding our physical universe, for specifying the nature and performance of products, and for exchanging goods in the marketplace. Don't get the impression that measurement drives the wheels of industry and commerce—it doesn't. But it does permit the wheels to turn with minimum friction, and that is a very important task.

Historically, NBS has also served as a general purpose technological laboratory for many federal agencies. While the mission agencies have extensive capabilities of their own, they often turn to the Bureau for assistance in those tasks whose technical demands exceed their resources. For example, the Bureau provides many of the standards and measurement techniques needed by the Environmental Protection Agency to make reliable air pollution measurements in the field. For the Department of Justice, it is developing specifications for law enforcement equipment that can help all police departments purchase reliable and useful equipment. For the Defense Department, NBS is working on ways to measure, understand, and improve the reliability of complex electronic assemblies.

Indeed, when a technical task arises for which there is no mission agency, the Bureau, because of its competence and flexibility, is often called on to serve. Dr. Ambler will address the Bureau's primary functions and some of the consequences of calling upon the Bureau over the years on an *ad hoc* basis as a "technologist of last resort." Accordingly, I will move on to discussing what I see as a potential extension of the Bureau's role rather than continuing to review the past.

It is now just under six months since the President announced my appointment. In that time serious questions about our international technical/economic position have demanded action from the administration and Congress. Shoes, consumer electronics, clothing, steel, and many other industries have felt the impact of the growing industrial competence of our neighbors throughout the world. Other industries will feel that impact with increasing frequency and from a growing list of countries. I've just returned from a three-week stay in the People's Republic of China where I visited large numbers of factories, attended three major industrial fairs, and interviewed dozens of scientists, engineers, and managers. Most importantly, I had the opportunity to examine their product and process development over the past six years. They are still behind us in technical competence, but even that gap is closing fast.

Our declining national technological and industrial lead is a reality with major implications for

consumers, workers, industry, and government. It is a depressing reality, but not one that is irreversible. Our neighbors are catching up because they have made catching up a matter of national commitment. Germany has a major national program going on in automated parts manufacturing; Japan is in the process of investing over $300 million in the basic technology of large-scale integrated circuits and the Peoples Republic of China, with only five million phones for a population of almost a billion people, is busy designing and experimenting with solid-state electronic telephone exchanges.

In the past there was no such concerted foreign activity and our private enterprise system was able to keep up in the preeminent technical/industrial position whose fruits we have so long enjoyed. Under these changed circumstances, we should consider what actions the federal government, and specifically NBS, could take to foster technological innovation.

One activity in which government could participate while causing minimal distortion of the private enterprise system is the development of what we have come to call industrial infratechnology. As the name implies, infratechnology is that underlying set of techniques and capabilities on which individual firms can build the actual products and processes that make them competitive. The Large Scale Integrated Circuit (LSI) program in Japan is an example. Its results will nowhere be "sold" directly; they will, however, form the basis for an increased competitive position for Japanese watches, computers, television sets, digital machine tools, and, if history is a reliable teacher, for products that do not now exist.

Our government, of course, also supports infratechnology development. DoD and NASA have long traditions in aerospace; HEW, Agriculture, DoT, DoE and others all play roles that are appropriate to their missions. There is little doubt that the role of government will receive increased attention as the Nation seeks to regain its competitive technological position. If it is eventually decided that the federal government should increase its role in infratechnology development, I believe the Bureau will be called upon to play a special part with regard to the support of those infratechnologies not falling within the purview of the mission agencies.

To lessen the lead time that will be required if the Bureau is directed to take a major role in infratechnology development, to address some immediate problems such as exist in the shoe industry, and to give us operating experience in what Under Secretary Harman has called the manufacture of competitive advantage for U.S. industries, I am proposing, for consideration by the Department of Commerce, the establishment of an NBS program aimed at the advancement of industrial infratechnology, tentatively entitled the Cooperative Technology Program. Initial implementation of this program, however, must await completion of a formal review and approval process.

Nevertheless, I would like to share with you my conception of the program. It would be built upon cooperation between government and industry and have as its purpose the development of new knowledge, prototype technology, and mechanisms that will promote the generation, improvement, transfer, and application of technologies. Projects would be conducted only in those cases where the private sector, acting alone, cannot or will not do the job,

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"When a technical task arises for which there is no mission agency, the Bureau, because of its competence and flexibility, is often called on to serve."

and where there is a strong demand among users for solving the problem or exploiting the opportunity.

My office and the Bureau have collaborated actively, and are continuing to do so, in developing a detailed proposal for reorganizing NBS to provide an organizational structure that will ensure the utilization of the Bureau's special skills and the productive collaboration of the private sector. Productive collaboration with the private sector will benefit the Bureau as well as industry. We have long known that new technology more often stimulates new science than the other way around. Any proposed reorganization, of course, depends on review and approval by the Department and by the President's Reorganization Project staff. Dr. Ambler will discuss this subject and its status in more detail. However, I will say in developing our proposal we have had as a goal increased mobility of Bureau scientists and engineers between the laboratory and the development projects. Both research and common sense tell us that ideas are transferred most effectively by the motion of people rather than by paper. This increased mobility will refresh not only our industrial armamentarium but the interests, concerns and skills of the Bureau's laboratories.

To sum up, the National Bureau of Standards has long held a position of excellence. Gearing up to build on that position through serving the Nation's needs offers it the opportunity to move from excellence to greatness. □

AMBLER—

Problems, Prospects, and the Search for a Proper Balance

Dr. Ernest Ambler, with over 24 years of experience at the National Bureau of Standards in both research and management, became acting director in July 1975. He was recently nominated director of NBS by President Carter, and action by the Congress is pending at the time of this writing.

THE National Bureau of Standards was created by Congress in 1901, and our basic legislative mandate has been updated over the years. In brief, the Organic Act under which we operate assigns us 5 major functions:

- Developing, maintaining, and disseminating standards of physical measurement
- Determining physical materials properties and physical constants
- Developing test methods for materials, mechanisms, and structures
- Establishing standard practices in cooperation with Government agencies and the private sector
- Providing advisory services to Government agencies

Our activities under this act are twofold. First, NBS assures the accuracy and uniformity of measurements made in science, industry, and commerce through traceability to national measurement standards. Second, we apply our technical competence to assist in the solution of national problems.

Our physical facilities are among the finest in the world. NBS headquarters are located on a 576-acre [233-hectare] site in Gaithersburg, Md. This site has 27 buildings, including seven general purpose laboratories of 3 or 4 floors each; a nuclear reactor used in a variety of research programs; a fire research facility; a building for sound measurements; and other buildings devoted to special research needs.

In Boulder, Colorado, we share a 205-acre [83-hectare] site with 2 other Commerce agencies. Boulder is the home of our work on time and frequency, cryogenics, and electromagnetic measurements. We also operate two radio stations that broadcast time and frequency information, one in Colorado and one in Hawaii.

Facilities, of course, are but one necessary element in a successful program, another being a top quality staff. Fulltime permanent staff number 3,061, of whom 2,608 work at Gaithersburg and 453 at Boulder. Our scientific staff includes 626 with Ph.D. degrees, 298 at the Masters level, and 434 with Bachelors degrees. Besides the expected experts in physics, chemistry, and engineering, we have architects, mathematicians, psychologists, lawyers, economists, and computer scientists on our staff. This broadened expertise allows us to better understand the complex relationship between the technical aspects of a problem and the social, economic and legal contexts, and therefore to make a more useful response.

At the present time our scientific and technical staff is organized in broad areas of responsibility. To be specific, we have Institutes for:

- Basic Standards
- Materials Research
- Applied Technology
- Computer Sciences and Technology

While this structure has served us well in the past, new demands and new opportunities call for a more effective organization, a point to which I will speak later in my statement.

Our final major resource—money—comes to us from three different sources. The major amount, about $70 million this fiscal year, is a direct appropriation from Congress. This money is used in meeting our obligations under the Organic Act and other pieces of legislation that assign us direct responsibilities.

We also assist other federal agencies in problems of a scientific and technical nature. The work we do for other agencies is directly related to our mission and draws on our reputation for credibility in technical matters. This year, we shall receive $48 million from other agencies for our services.

Finally, we provide various services to both government agencies and the public for which we charge a fee, services such as calibrations and tests, the sale of standard reference materials, and use of our computer facilities. From these activities, we expect an income of $5.6 million this year.

Let me now turn to a description and assessment of current operations at NBS. As my statement has indicated, we have excellent facilities and staff, and a reputation for quality work. Congress has recognized our capabilities by giving us a variety of new assignments in the past 12 years.

The list of these assignments is quite comprehensive, and includes assignments under the Brooks Act of 1965, an Act that gave NBS major responsibilities in the automatic data processing area, the Federal Non-nuclear Research and Development Act of 1974, the Fire Prevention and Control Act

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"First, we are the nation's central reference laboratory."

"The other part of our mission involves applying our technical know-how to assist other federal agencies and other segments of society . . ."

of 1974, the Energy Policy and Conservation Act of 1975, and the Resource Conservation and Recovery Act of 1976.

We have responded quite diligently to these new assignments. For example, pursuant to the Federal Non-nuclear Energy Research and Development Act of 1974, NBS is evaluating for the Department of Energy, under their funding, energy related inventions submitted by individuals and small businesses. As of September 30, we had received 6,260 evaluation requests and completed our evaluation on 5,299 of them.

Another example is NBS's responsibilities under the Energy Policy and Conservation Act of 1975. The Act requires FEA—now the Department of Energy—to direct NBS to develop methods for measuring the energy consumption of household appliances. We have proposed measurement procedures for 30 products, such as water heaters, televisions, and clothes dryers, and are now reviewing comments before making final recommendations.

In many pieces of legislation NBS is given neither direct assignment nor funding, and we often have trouble obtaining funds in a timely fashion from the prime agency for support of our efforts. Moreover it is extremely difficult to obtain support for the long range aspects of the problem. We have had to divert people and money from other NBS programs. This reprogramming has diluted our ability to provide some basic scientific competence. We are concerned that the balance at NBS has shifted too far towards immediate problem solving and away from long term research and maintaining a high level of broad-based technical competences that will be needed in the long run.

Our statutory Visiting Committee, a group composed of outstanding leaders from industry and universities, meets at NBS twice yearly for in-depth examination and evaluation of resources, facilities, programs, and management. This group has also concluded that diverting money and people from long term programs to meet new responsibilities has reduced the level of our basic scientific competence. The shifting of people to meet new requirements, and the erosion of basic scientific competence, has led to an uncertainty and frustration in parts of the organization that I have not seen before in my 24 years with NBS.

Steps are being taken, both internal and external, to analyze the full extent and nature of the programmatic funding and personnel problems of NBS. The Administration will then consider what needs to be done to resolve these problems.

As Dr. Baruch has testified, we are working together in developing a detailed proposal for reorganizing NBS. Goals of the reorganization include formalizing certain elements of our work, providing a proper balance between solving immediate problems and maintaining a high level of technical competence as a broad-based resource, increasing staff mobility between the laboratory and development projects, increasing the effective utilization of special skills, and fostering productive collaboration with the private sector. Any proposed reorganization depends upon review and approval by the Department and by the President's Reorganization Project Staff. While discussion of the full details of this reorganization should await that review and approval, I would like to share with you some of my thinking.

As I said earlier, there are two major parts to the Bureau's mission. First, we are the nation's central reference laboratory. In this role, we develop and provide measurement methodology, standards, and evaluated data that form the cornerstone of our economy and are used by a broad constituency of scientists and engineers in industry, commerce, government and universities. This function necessarily involves work at the very forefront of modern science, and must, if it is to remain viable, include some internationally competitive research at the frontiers of knowledge.

The other part of our mission involves applying our technical know-how to assist other federal agencies and other segments of society, that is, state and local governments, educational institutions, industry and the general public. This second role has been present over the years in varying degrees.

NBS has been engaged in cooperative technology from the very beginning, and there are many examples of notable successes. In World War I, when our European supply of optical glass was cut off, NBS helped establish a manufacturing capability in this country. During World War II, we provided

much of the technical base needed for the growth of a domestic synthetic rubber industry. More recently, we worked with industry to develop an extremely stable material for use in manufacturing gage blocks of high permanence. The gage blocks have contributed to the economical manufacture of precision assemblies, and the material itself has found application in gyroscopes and other precision instruments.

We have also worked closely with other federal agencies in technology development. For example, our pioneering work on defense projects during World War II led to such advances as printed circuits and miniaturization of electronic components. More recently, we created a major laboratory for testing the safety of seat belts, braking systems, and auto body design. Once fully established, this entire operation was transferred to the Department of Transportation.

In the field of health care, NBS has worked with the American Dental Association for over 50 years. Practically every dental filling material on the market today was developed or improved through these joint efforts. The high speed turbine drill, now used by almost every American dentist, was developed at NBS, as was the panoramic x-ray machine. Obviously, the ultimate beneficiaries of this work are the American people.

In responding to new legislative mandates we have continued to operate in a cooperative mode. For example, the Energy Policy and Conservation Act of 1975 requires us to develop test procedures for determining the characteristics of re-refined oil. In attacking this problem one of our first moves was to interest the Association of Petroleum Re-Refiners in placing an oil-measurement expert with us for a year or two. They did so, and we are benefitting greatly from this expertise. Incidentally, we have 72 such people now at NBS from various industries, trade associations, and technical organizations, working with us on problems of mutual concern.

These are just a few examples of the history of the Bureau's work in diverse areas of science and technology. The Administration is considering proposals involving NBS which would attempt to enhance the role of technological innovation in economic growth.

A major question exists as to the proper balance between solving immediate problems and maintaining a high level of technical competence as a resource for problem solving. Perhaps the answer is unknowable in objective terms, but my own judgment, and the advice of the NBS Statutory Visiting Committee and the National Academy of Sciences Evaluation Panels, is that the present balance has shifted too far in the direction of immediate problem solving. This is not to imply that we should hold back from applying our expertise to the solution of immediate national problems. Rather, it is a concern for maintaining a proper balance between that and the building of scientific muscle necessary for the long range viability of NBS as a first-rank technical institution.

We have a long range goal of rebuilding staff competence. As Dr. Baruch has testified, we have been considering reorganizing NBS. We are developing a proposal which reflects goals of providing for a proper balance, providing for more flexibility and providing for more effective applica-

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"We have a long range goal of rebuilding staff competence."

tion of resources to our mission. I must stress, however, that this proposal has not yet been reviewed by the Department and the President's Reorganization Project staff. Until that review is completed, detailed discussion of an actual reorganization would be only speculative. Consistent with the policies of the President, we have sought the views of the entire NBS staff and seek the view of the Congress and all other concerned parties.

Because we have sought the views of the NBS staff, the press has reported details of what has been referred to as a coming reorganization. That is incorrect. What we have now is only a proposal which may very well be changed. However, I would like to share with you my thoughts. The technical program staff could be divided into two major groups—a National Measurement Laboratory and a National Engineering Laboratory. A National Measurement Laboratory, as its name implies, would be responsible for the national system of physical, chemical, and materials measurement. A National Engineering Laboratory would be responsible for research, development, and services allied to solving national problems in engineering and applied science. Its programs could include Fire Research, Building Technology, and Consumer Product Technology. In addition to supporting and carrying out the current programs of NBS, each of the two major laboratories could be charged with building in-depth competences for the future.

A third group, composed of National Centers for Cooperative Technology, could be established to increase the Bureau's coupling with industry, government, and the universities. We are exploring the role such Centers could play in the development, improvement and transfer of technology in instances where the private sector, acting alone, cannot or will not do the job. The word "cooperative" is the key. Problems could be identified, programs initiated, monitored, and phased out, all in close "cooperation" with the users. The Center could work with industry, state and local governments, and in some cases foreign groups, particularly in less developed countries. The Centers could use, when appropriate, relevant experts in the two major NBS Laboratories, as well as in private organizations.

As Dr. Baruch testified, the impetus for the proposed creation of the Cooperative Technology Program, which is distinct and separate from any reorganization which may or may not involve the creation of National Centers for Cooperative Technology, is the realization that the application of technology plays a critical role in economic growth. Innovation and the process of technology transfer are not sufficiently well understood, and we view this endeavor as both an opportunity to contribute and to learn. Certainly we should be concerned with the adverse side-effects of the introduction of new technology, but we should also become more concerned, than we have been in the immediate past, with the beneficial effects of technological innovation on the economy.

I am excited by the prospects for the future and look forward to a continuing dialog with this Committee. □

PECK—
Warnings and Recommendations

Charles E. Peck is vice president of the Building Materials Group of Owens-Corning Fiberglass Corporation. He spoke for the members of the NBS Statutory Visiting Committee, each chosen by the Secretary of Commerce from among the nation's prominent scientists and industrialists.

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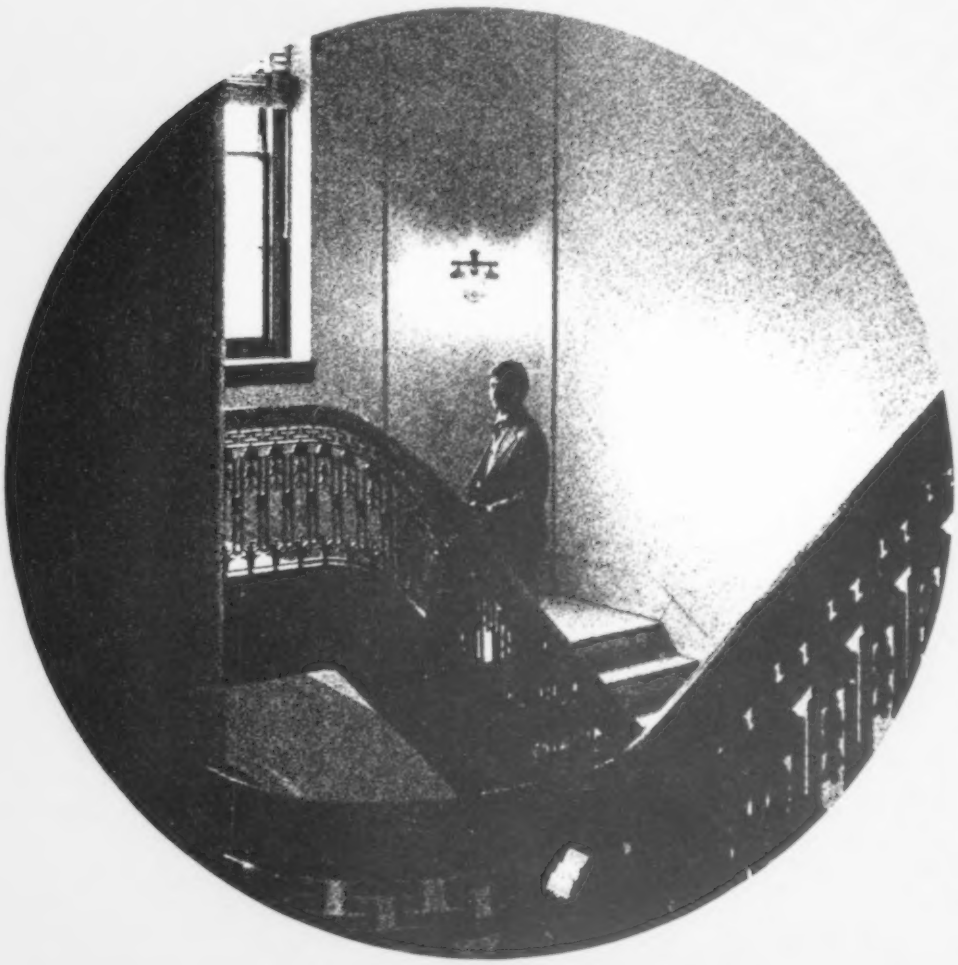

THE same public law that created the National Bureau of Standards charges the Visiting Committee to visit NBS at least once a year and to report to the Secretary of Commerce on the efficiency of its scientific work and on the condition of its equipment. The procedure calls for each Committee member to serve for five years. This is done on a rotating basis, so that each year one drops off, and one is added. As this is my fifth year on the Committee, I have the honor to be Chairman.

The other members of the Visiting Committee this year were Dr. Edwin Gee, Senior Vice President, E. I. du Pont de Nemours and Company; Professor Robert Dicke, Princeton University; Dr. Dale Compton, Vice President, Research, Ford Motor Company; and Mr. William Carey, American Association for the Advancement of Science.

In its review of the National Bureau of Standards, The Visiting Committee found many very qualified people doing exceptionally good scientific work. Because the Department of Commerce, including Secretary Juanita Kreps, is very familiar with the operations of NBS, we felt it was appropriate to focus our report on the problems of the Bureau, and we spend little time reporting on its many strengths.

The remarks of the Committee, which follow, are taken verbatim from our written report of September 15, 1977, to Secretary Kreps:

"In keeping with the statutory requirement of an annual written report from the Visiting Committee of the National Bureau of Standards, the following is a record of our September 6, 1977 discussion.

"The Visiting Committee of the National Bureau of Standards appreciates that you rearranged your schedule to meet with us. NBS has critical problems and we feel the personal support and direction of the Secretary of Commerce is very important. We are pleased to have had the opportunity to present these concerns to Dr. Harman, and that he took the time to sit in with us during our meeting with you.

"NBS is on the brink of serious trouble. The persistent retrenchment that has taken place threatens to bring NBS to a mediocrity that is unacceptable. We recognize that your administration has inherited, not created, these problems. However, it will have to be your strong leadership that effects a change.

"Shocking gaps exist in NBS' ability to carry out its basic assignment, even without supplemental assignments. New assignments thrust on the Bureau without funding or personnel have forced NBS leadership into defensive management, whereby long-range programs are sacrificed to salvage short-term objectives. The declining quality of work is reaching a critical stage. One study indicates that basic research in constant dollars may have dwindled to half the level of ten years ago. Fifteen new laws since 1965 have given NBS assignments, yet the NBS overall budget in constant dollars has not increased.

"There are confusing inconsistencies in the management direction NBS has received from the Department of Commerce and from OMB (the Office of Management and Budget). Perhaps you are familiar with these illustrations:

a) The shortfall in response to the Brooks Act [the Act passed in 1966 giving NBS specific responsibilities in the area of computer science and technology].

b) The energy-efficient household products assignment from Congress, for which OMB approved personnel and effort levels at NBS, told NBS the assignment would have to be funded by FEA [Federal Energy Administration], then withdrew those funds from FEA.

c) The Resource Conservation & Recovery Act of 1976, whereby Congress gave NBS only two years to develop guidelines for specifications for waste-recovered materials, yet OMB denied NBS funds.

"NBS has had four different directors in ten years. The present head has been in an 'acting' status for two years. The Director of the Institute for Applied Technology has been in an 'acting' status for a full year. Recently, The Director of the Institute for Computer Sciences resigned. 'Temporary' management cannot do a strong job.

"Perhaps the most important signal of trouble is the effect on the talented people who make NBS a strong institution. Weakening morale and individual concerns for lack of consistent direction and support are plain. Effects are apparent also in the difficulty NBS has in attracting the very best graduating scientists.

"We believe that some key reasons for these problems are:

a) The laissez faire attitude and the low priority that the Department of Commerce has given NBS.

b) That those at OMB responsible for NBS have non-technical backgrounds with little understanding of the relevance of this highly scientific work or how it should be managed.

c) The new Congressional assignments continue to be given without additional resources.

"Despite these problems, NBS is doing a lot of very good work. Adversity has not yet broken morale. It is not too late for good management and

firm support to allow NBS to retain its strong reputation for excellent work.

"We feel the solutions are clear.

- Either the Department and the Secretary herself should intervene strenuously to obtain more resources, or
- The Department should halt new assignments and advise Congress that the work cannot be done. Such communication should not be left to the NBS director, but handled directly by the Department.

The Visiting Committee strongly recommends the following:

a) Relief in the 1979 budget should be the first step.

b) Confirmation of Dr. Ernest Ambler as permanent NBS Director, and approval of his recommendations for IAT and ICST Institute Directors. We are pleased to learn from Dr. Jordan Baruch that the Department has forwarded the recommendation of Dr. Ambler to the White House. We hope approvals can be expedited.

c) A moratorium on new statutory assignments not directly funded by Congress.

d) Open discussions with Congress on:

1. The Brooks Act shortfall
2. Energy Conservation assignments
3. Resource Recovery assignments.

"Although NBS is in serious trouble, a few simple but strong management actions can avoid crisis. We believe that your personal interest and support in these actions can quickly maintain NBS as the world's finest standards and measurement laboratory. As individuals, or as a group, we volunteer our services in any way that might be useful."

On behalf of the Visiting Committee, I would express appreciation for the opportunity to present this point of view to your subcommittee. We feel the National Bureau of Standards is a most important institution and that this overview hearing is timely and appropriate. □

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"Although NBS is in serious trouble, a few simple but strong management actions can avoid crisis."

BAKER—
A Current Assessment

Dr. William O. Baker testified at the NBS Oversight Hearings as a member of the evaluation panels chosen by the National Academy of Sciences-National Research Council to review NBS programs and facilities. The panels report their findings to the director of NBS and to the NBS Visiting Committee.

Baker began his testimony by noting that there have been many advances in science and technology and the recognition of new national problems in the six years since the last Congressional oversight hearings on NBS. He stressed the importance to industry and the nation of "reliable scientific and engineering data acquired through accurate measurements," and the need for "standards by which these measurements can be calibrated and coordinated throughout the nation."

NBS, according to Baker, is responsible not only for meeting these needs today, but also must "provide improved measurement technology in anticipation of future needs of industry, commerce, and research."

"Whether NBS will continue to be successful under pressure of new requirements from government, industry, and society is one of the factors that makes these hearings important," said Baker.

The remainder of his testimony appears in full on the following pages.

DURING the many years that I have been aware of its activities, the Bureau has been a forum for the exchange and dissemination of scientific and technical information, and it has been a major force in the encouragement of innovation. It not only has furnished the language for science and technology, but it also has become the scientific conscience of these communities. It has set high standards for research, and scientists have become accustomed to expect that they can visit the Bureau to obtain new ideas and to confirm the validity of their work. My overall assessment is that, through the National Bureau of Standards, Congress has provided the science and technology of this nation with an invaluable support.

Information about the status of NBS technical programs is gathered on an annual basis by several Evaluation Panels, of which I serve as the Chairman of the Steering Committee. These Evaluation Panels, which are organized by the National Research Council at the request of the Department of Commerce and NBS, provide an independent, outside evaluation of NBS research and technical activities. Annual reports are delivered to the Director of NBS. There have been over 900 participants on the panels since the program began in 1959. Each panelist usually serves for a three-year term. There are now 6 panels and 24 subpanels, but the number and makeup of the panels are changed each year to suit the task. Individual panels report detailed findings and recommendations on specific technical projects, and over the years the Bureau has been warmly receptive to the reports of the panels. The primary responsibility of my Steering Committee is to identify general problems that need to be brought to the attention of the NBS statutory Visiting Committee and the Secretary of Commerce.

A reorganization plan for NBS is under consideration but it is so recent that the Evaluation Panels have not had time to consider the implications of the plan. I will briefly summarize the most recent general findings of the panels in terms of the old organizational structure of the Bureau.

Institute for Basic Standards

The Institute for Basic Standards (IBS) includes work in acoustics, mathematics, mechanics, electricity, heat, optical physics, radiation, cryogenics, quantum physics, electromagnetics, and time and frequency. The panels believe that IBS has done a thorough and effective job of determining new directions and phasing out less relevant work.

However, there is great concern from the panels about the inability of IBS to get additional funding and personnel slots for new initiatives that deal with urgent national problems. The necessary resources must then be obtained by reprogramming at the expense of other programs within NBS.

The Bureau must be as responsive as possible to demands placed upon it by new legislation, but it is equally clear that the intent of the original legislation that created NBS has in no way been rescinded The high priority given to work related to more recent legislation tends to cause NBS to drift in the direction of special interests that prevail at the moment, and these generally involve relatively short-range requirements for action. As a result, activities of NBS dealing with the intent of the Organic Act, which generally involve on-going, long-range needs within broad areas of society, are diluted.

The forces that have led to cuts in long-range programs must be reversed if irreparable damage to essential resources is to be avoided. Indeed, the efforts to be responsive to the problems growing out of the recent legislation tend to reduce the capability to be responsive to anticipated future legislation.

Institute for Materials Research

The Institute for Materials Research (IMR) has programs in analytical and physical chemistry, polymers, metallurgy, and inorganic materials. The critical problem in IMR is the increasing amount of short-term mission research. Some assignments are legislated, and some are on request from other agencies. NBS serves as a source of common research for all federal agencies, but it is becoming difficult to maintain the technical strengths required for the future.

Some limit must be put on the number of new assignments given to IMR unless funds and personnel become available. The mission-oriented programs must include some support for basic skills that will meet the needs of the future.

Institute for Applied Technology

The Institute for Applied Technology (IAT) has programs in electronic technology, consumer product technology, building technology, and fire research. The panels believe that IAT demonstrates a unique capability in developing applied research programs and coupling with many agencies and organizations.

The panels note that the Electronic Technology Division has made important contributions to the electronics industry. The NBS fire program has been highly praised by the panels in recent years.

IAT carries out its programs and responds effectively, quite often to mandated, short-term deadlines, but there are severe resource deficits.

Institute for Computer Sciences and Technology

The Institute for Computer Sciences and Technology (ICST) is the newest and smallest of the institutes. It has programs in systems and software, computer engineering, and information technology. The panels believe that the selection of tasks that ICST undertakes after weighing resources and tradeoffs represents a well-considered effort to go as far as possible toward meeting assigned responsibilities under the prevailing circumstances. The expectations of the Congress appear to be much greater than the resources and support supplied to ICST.

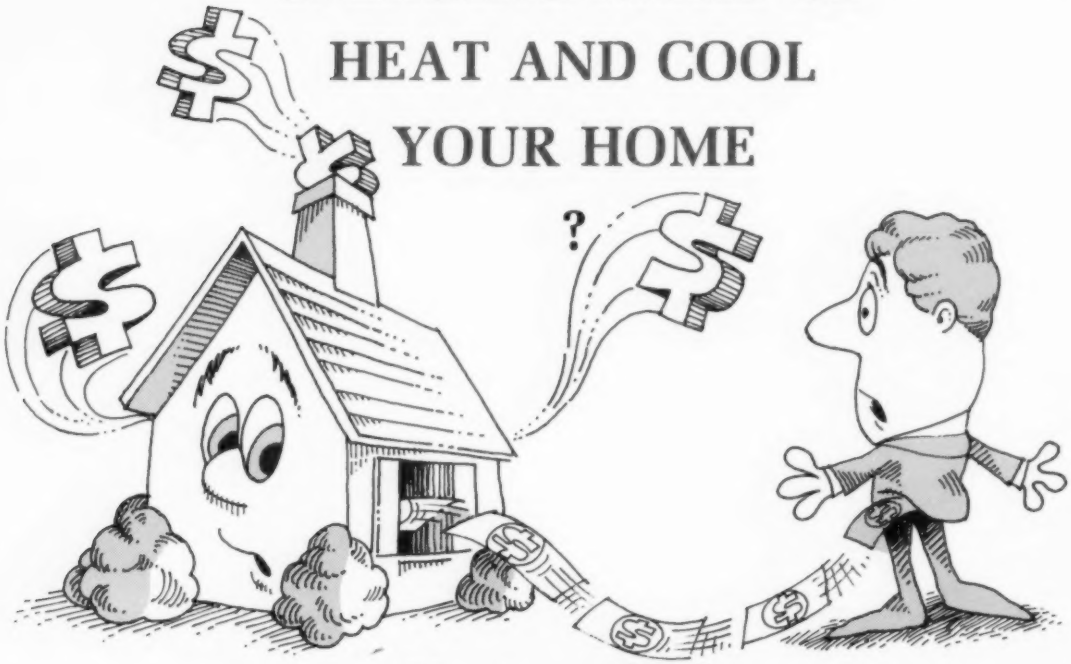
The current assessments of the Evaluation Panels highlight two points: (1) the technical and managerial talent at NBS is of high quality, and (2) NBS cannot be stretched beyond its resource limits and still deliver on both its fundamental mission and its many new assignments.

Let me emphasize that the technical work of the Bureau is of the highest caliber. What the Bureau is able to do with the resources available, it does well. The National Bureau of Standards continues to provide, as it has in the past, the standards, the measurement technology, the critical standard reference data, the Standard Reference Materials, and the information processing standards that are necessary for increased productivity, equity in commerce, continued innovation, and more efficient government operation. Indeed, it appears that new assignments are given to NBS because of the great trust that can be placed in an institution with such a high reputation. To carry out its mission and meet new responsibilities, the Bureau must receive the increased support called for by the Evaluation Panels.

The Steering Committee of the Evaluation Panels has reported to the statutory Visiting Committee and the Secretary of Commerce. The panels support the detailed assessments of the Visiting Committee, which are described by Mr. Peck. The conclusions of the Visiting Committee are consistent with the findings and recommendations of the scientists, engineers, and industrialists who have evaluated the programs at NBS under the auspices of the National Research Council. □

"My overall assessment is that, through the National Bureau of Standards, Congress has provided the science and technology of this nation with an invaluable support."

ARE YOU SPENDING MORE TO HEAT AND COOL YOUR HOME



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Making the Most of Your Energy Dollars is a new consumer guide from the Commerce Department's National Bureau of Standards, in cooperation with the Federal Energy Administration.

For your climate and the type of energy used to heat and cool your house, this booklet lets you find your best investment in energy conservation improvements. This investment gives you the greatest possible net savings in your heating and cooling bills over the long run.

Use the booklet to figure out just how much insulation, storm windows and doors, weather stripping and caulking are needed for your house—and what they will cost. Not a how-to-do-it book, but a "how-much" guide to energy conservation investments.

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U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards
FEDERAL ENERGY ADMINISTRATION / Office of Energy Conservation and Environment

STANDARDSTATUS

PROGRESS IS BEING MADE IN SOLAR ENERGY STANDARDS DEVELOPMENT

Three years ago, a person seeking information on standards for solar energy systems and components would have drawn a blank—literally. Today, there are at least 7 published standards, codes, and performance criteria documents available and several more are nearing completion. Such progress is largely the result of response to the Solar Heating and Cooling Demonstration Act (Public Law 93-409). Enacted in September 1974, the law called for the early development and commercial demonstration of the technology of solar heating and combined solar heating and cooling systems. This was to be accomplished through residential and commercial demonstration programs and through related research and development projects.

From the beginning it was recognized that the goals of the act could not be carried out without performance standards and criteria. Standards are needed to establish acceptable minimum requirements for health and safety as well as acceptable minimum levels of technical performance. Moreover, standards provide a framework for consumer acceptance, mortgage insurance, financial incentive programs, and industry commercialization. In fact, the viability of the solar energy system industry hinges on the availability of such standards.

The National Bureau of Standards was named in the original legislation to provide technical support to the Energy Research and Development Administration (now part of the Department of Energy) and the Department of Housing and Urban Development, the agencies responsible for carrying out the law. NBS activities are focused in the Center for Building Technology under the direction of Robert Dikkers, Manager of Solar Energy Programs.

One of the first tasks NBS undertook was to formulate a plan to guide the development and implementation of standards for solar heating and cooling applications. The plan contained background information on the need, implementation, and general scope of standards that may be required. It also recommended actions for the early development and implementation of draft and national consensus standards for solar heating and cooling systems, subsystems, and components. The plan is being revised and updated in consultation with interested members of the building community so that needed draft standards can be developed or existing standards modified.

Last year, the American National Standards Institute Steering Committee on Solar Energy Standards Development adopted the NBS-developed plan. This action provided a starting point for coordinated, effective efforts by the government and the private sector in developing needed standards.

Meanwhile, NBS engineers have been actively involved in the actual development of draft standards, which help provide the framework for national voluntary consensus standards. Two standards based on NBS drafts, one for the thermal performance of solar collectors and one for storage devices, were issued early in 1977 as American Society for Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) standards. NBS also initiated five research projects to provide the technical basis for standards for materials used in solar heating and cooling systems. Using field studies and lab-based research, NBS engineers are identifying materials problems in existing and operational solar energy systems. Along with previously identified problems and data from the national demonstration program, the materials research will result in draft test standards for sealants, collector cover plates, collector insulation, and collector absorptive coatings. Development of these draft standards is being carried out in close cooperation with the American Society for Testing and Materials Subcommittee E21.10 on Solar Heating and Cooling Applications.

A key part of federal efforts is in producing and refining interim performance criteria intended for use in the various phases of the residential and commercial demonstration programs. These performance documents, along with Intermediate Minimum Property Standards developed for HUD, will ultimately result in definitive performance criteria that can be used to establish recommended building code provisions for incorporation into model, state, and local building codes and federal specifications.

NBS has developed interim performance criteria for the residential demonstration program and has nearly completed an update. The commercial performance criteria for solar heating and cooling systems, originally done by the National Aeronautics and Space Administration, have been revised by NBS. A further update of these criteria is expected late this year.

A major accomplishment in the standards area was the development of intermediate standards for solar hot water and space heating systems. These were issued last summer by HUD as a supplement to the FHA Minimum Property Standards. Developed for HUD by NBS, they establish quality levels for solar heating and domestic hot water systems for residential facilities designed and constructed under HUD programs, including nursing homes, intermediate care facilities, and single and multi-family residences. The standards will serve as the basis for mortgage insurance acceptance and may be used at a later date to qualify systems or components for acceptance under pending tax credit programs.

The success of the demonstration program and the future of solar energy in the United States may ultimately depend on a certification system for solar energy components and systems. NBS is working with the Department of Energy, HUD, and independent organizations on procedures under which solar collectors can be tested, rated, and labeled in an industry-administered certification program. Such a program would provide an objective basis for consumer protection programs and would promote the use of solar energy systems by informed consumers. In addition, it would stimulate manufacturer competitiveness and accelerate product improvements.

Additional information on the NBS Solar Energy Program and a list of publications may be obtained by writing the Manager, Solar Energy Programs, Center for Building Technology, National Bureau of Standards, Washington, D.C. 20234.

MJ

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CIPM MEETING REPORT

Several actions of the International Committee for Weights and Measures, at a meeting in late September of last year, are of interest to people working in measurement fields.*

Ernest Ambler, Acting Director, National Bureau of Standards, Administration A1134, 301/921-2411.

At its most recent meeting, the International Committee for Weights and Measures adopted a recommendation of primary importance:

—That the value of 683 lumens per watt be used for the spectral luminous efficacy of monochromatic radiation of 540.0154 × 10^{12} hertz, for photopic, mesopic and scotopic vision.

In the International System of Units, the unit of luminous intensity, the candela, is defined in terms of a blackbody maintained at the temperature of freezing platinum—about 2045 K. The experimental difficulties and uncertainties associated with use of the platinum point blackbody are quite formidable, and many national laboratories seldom, if ever, operate such a source. They depend instead on standard lamps of high stability, or on conversion of radiometric measurements to a photometric base. Such conversion may proceed from detectors that involve the relatively easy and quite accurate measurement of electrical power, or from spectral measurements.

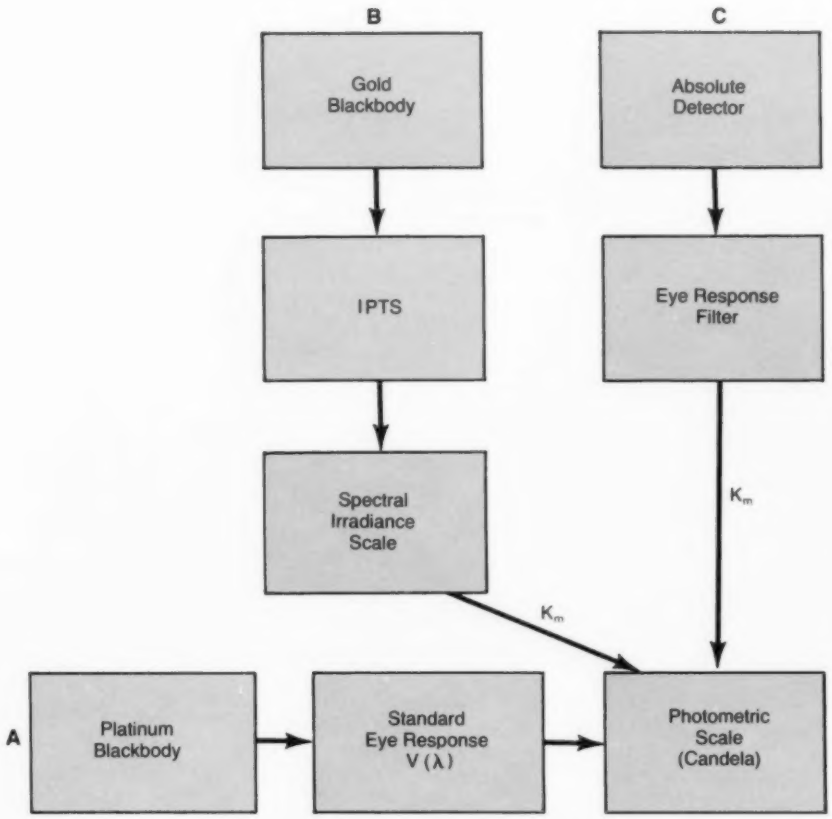

Figure 1—While the text of the SI defines the candela in terms of the platinum point blackbody (a), developments in radiometry have led to technical alternatives involving spectral radiometry (b) or absolute detectors (c). By defining K_m, the basis for converting radiometric to photometric data is firmly established.

In 1975 Blevin of the National Measurement Standards Laboratory (Australia) and Steiner of NBS proposed** a redefinition of the candela and the lumen. Their proposal gave focus to work already underway in many laboratories, and led to submission of values, ranging from 675 to 684 lumens per watt, by nine international laboratories. The adopted value of 683 lumens per watt is recommended for use when calculating a photometric quantity from its corresponding spectroradiometric quantity. Widespread use of the value should lead to better measurement agreement among national laboratories.

Adoption of this value does not of itself change the present SI definition of luminous intensity. Doing so will involve further actions by the International Committee that are more related to the philosophy of units than to specific laboratory measurements. Such topics are currently under active debate in the Consultative Committee for Units, and recommendations are expected from them before the next International Committee meeting.

Another matter placed before the International Committee at the latest meeting is the means by which the uncertainty of a measurement should be expressed. This is an extremely important question, and one that, because of the vast range of user

*The Treaty of the Meter, 1875, established a General Conference on Weights and Measures, a group meeting at least once every 6 years (currently every 4 years) at which each of the current 45 member nations is represented. An 18 member International Committee for Weights and Measures is responsible for administrative and technical matters between Conference meetings, and proposes actions for consideration by the Conference. (The International Committee for Weights and Measures is abbreviated CIPM from the French Comité International des Poids et Mesures.) Dr. Ambler is the U.S. member of the International Committee, and the National Bureau of Standards is active on many of the Consultative Committees that assist the International Committee.

**Redefinition of the candela and the lumen, *Metrologia* 11, 97—104 (1975).

needs, does not lend itse.f to a universal solution. For example, a national laboratory might express uncertainties in terms of a rather complicated statement, while a final user would generally prefer a simple statement with a single number that might say an instrument does or does not comply with a given regulation.

The International Committee has established a working Committee to consider this problem. It was agreed that guidelines for the statement of uncertainty are more useful than a single format, and the charge to the new Committee reads, in part;

"The ad hoc Committee . . . shall prepare a report on principles to guide the presentation of information about uncertainties, to be used throughout the international measurement system and at various levels within that system including national standards laboratories, secondary standards laboratories, and calibration certificates for the final user of the instrument. For this purpose it is important that the report contain guidelines for statements of uncertainty, but avoid in so far as possible unresolvable philosophical discussions on statistical theory. The committee should consider existing policies of the various national standards laboratories on statements of uncertainty and seek a suitable international consensus, being careful to avoid procedures that lead to loss of scientific information or that make post-analysis of experiments and calibration impossible."

A report on this work is expected in time for the next International Committee meeting in 1979. There is some urgency to the task, as a workable proposal could provide a single format for use by a wide variety of organizations.

At the International Committee meeting a number of other topics were discussed and reports received from the various Consultative Committees. Anyone interested in a fuller report should consult Dr. Ambler's trip report available in the Office of International Relations, Room A511, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

VIBRATIONAL CHEMILUMINESCENCE DETECTED FROM ION-MOLECULE REACTIONS

Ions and ion-molecule reactions play an important role in the chemistry of the upper atmosphere, in electrical discharges, flames, and laser plasmas. In a recent collaborative effort at the Joint Institute for Laboratory Astrophysics and the University of Colorado, a new technique has been developed to provide previously unobtainable information on the products of ion-molecule reactions. By detecting infrared chemiluminescence from ion-molecule reactions, detailed information about vibrational product states and the dynamics of ion-molecule interactions can now be obtained.

Stephen R. Leone, Division 274.00, Joint Institute for Laboratory Astrophysics (JILA) and Department of Chemistry, University of Colorado, JILA A407A, 303/499-1000, ext. 3505.

In a recent communication to the Journal of Chemical Physics 67, 2375 (1977), we* reported the first definitive experiments on the direct observation of vibrational chemiluminescence from an ion-molecule reaction. Two exceptionally powerful techniques were merged for the successful experiment: the flowing afterglow, used for years to study ion-molecule reaction kinetics, and state-of-the-art infrared detection capability, frequently used to study vibrational chemiluminescence of neutral reactions and laser-excited infrared fluorescence. Vibrational chemiluminescence was observed from the product CO_2 molecules in the associative detachment reaction $O^- + CO \rightarrow CO_2 + e^-$. An infrared signal was detected from the well-characterized antisymmetric stretch modes of the CO_2 molecule at 4.3 μm giving direct evidence that some of the product CO_2 molecules are formed with vibrational excitation. This method of detecting ion-molecule infrared chemiluminescence will allow detailed studies of the dynamics of ion-molecule reactions as well as some of the first measurements of deactivation rates of vibrationally excited ions.

Infrared chemiluminescence techniques have been extremely useful in revealing the details of reactive collisions between neutral species. These same techniques have not been previously applied to ion-molecule reactions because of the relatively low density of ions that can be obtained in laboratory systems. Convenient methods of producing ions usually achieve densities which are orders of magnitude lower than for neutral radical reactants. The difficulty of obtaining adequate signal-to-noise from the low densities of excited reaction products is formidable.

We have overcome these difficulties. Numerous improvements over the past years in state-of-the-art infrared detectors now make the detection of weak chemiluminescence signals feasible. The flowing afterglow, a technique developed since 1963 for quantitative measurements of ion-molecule reaction rate constants, offers an extremely versatile and relatively clean way to produce high ion densities in a well-controlled fashion. The flowing afterglow technique was first developed by scientists at the National Oceanic and Atmospheric Administration labs in Boulder. The apparatus used for these chemiluminescence studies resides in the University of Colorado chemistry department, where Professors Charles H. DePuy and Robert Shapiro and their students study organic ion-molecule reaction kinetics.

Only a few modifications to the conventional afterglow were necessary to perform the chemiluminescence experiment (fig. 1). Viewing ports for the infrared detector were added to the flow tube at 10 cm and 55 cm downstream from the ion source. A large-area, 1.3 cm × 1.3 cm, indium antimonide (InSb) infrared detector was used to observe the vibrational chemiluminescence. A narrow band interference filter selects the 2250-2390 cm^{-1} region of the CO_2 antisymmetric stretch manifold. The ion source was modified to

turn page

* Other collaborating scientists were Jean H. Futrell, 1976-77 Visiting Fellow, JILA, on sabbatical leave from the University of Utah; and G. Barney Ellison and Veronica M. Bierbaum, University of Colorado, Chemistry Department.

allow modulation of the ionizing electrons. The O^- ions are produced by electron bombardment of O_2 in a large flow of helium buffer gas. A mechanical backing pump and Roots blower produce typical average flow velocities of ~8000 cm/s. By modulating the electron bombardment source with a square wave potential on an accelerating grid, the O^- ions are produced in square wave packets with 100 percent modulation. The infrared detection electronics are readily synchronized to the grid modulation frequency for signal averaging enhancement. The flowing afterglow technique provides other essential diagnostics. The pressures, flows, and purities of the gases are carefully monitored and controlled. The quadrupole mass filter samples the flow of gas to measure and optimize the concentrations of desired ions. Movable reagent inlets are used to inject neutral reactants such as CO, at varying distances from the infrared port windows.

The O^- + CO associative detachment reaction was chosen for the first definitive demonstration of ion-molecule vibrational chemiluminescence because it has a minimum of obscuring effects. The typical negative and positive ion mass spectra from electron bombardment of O_2 in helium are very clean, consisting primarily of O^-, O_2^-, O^+, O_2^+ and impurity NO_2^- and Cl^-. Of these ions, only O^- is potentially reactive with CO.

From earlier studies of Mauer and Schulz, it is known that a large fraction of the electrons ejected during the reaction of O^- with CO have low kinetic energy, indicating that most of the 4.0 eV reaction exothermicity resides in internal degrees of freedom of the CO_2 product. In addition, available detectors can easily detect the 4.3-μm emission from the antisymmetric stretch vibrational modes of the CO_2 product if they become excited.

Typical O^- densities 55 cm downstream from the ion source were estimated to range from 10^6 - 10^8 ions per cubic centimeter. Upon injection of reagent CO before the infrared detection port, strong signals at 4.3 μm are observed from the CO_2 product of the O^- + CO reaction. Because there is spreading of the square wave ion packets by diffusion, the modulated chemiluminescence signal appears as a slightly rounded square wave. The CO_2 product emission correlates properly with the O^- density and the CO pressure. It is apparent that a substantial fraction of the CO_2 product is born with excitation in antisymmetric stretch vibrations. A CO_2 gaseous blocking filter provides further information that the CO_2 product is in fact highly vibrationally excited.

From the generally high signal-to-noise ratios in these experiments, the scientists at JILA and the University of Colorado are confident that more detailed and extensive experiments will reveal the vibrational population distributions in ion-molecule reactions. Such infrared chemiluminescence studies will provide important supportive details about the nature of potential energy surfaces involved in ion-molecule reactions, about autodetachment processes and lifetimes, on fragmentation dynamics, and on sources of infrared emission in the upper atmosphere and interstellar space. Since this new field holds great potenital for discovery, these studies are expected to extensively broaden our understanding of chemical reaction dynamics.

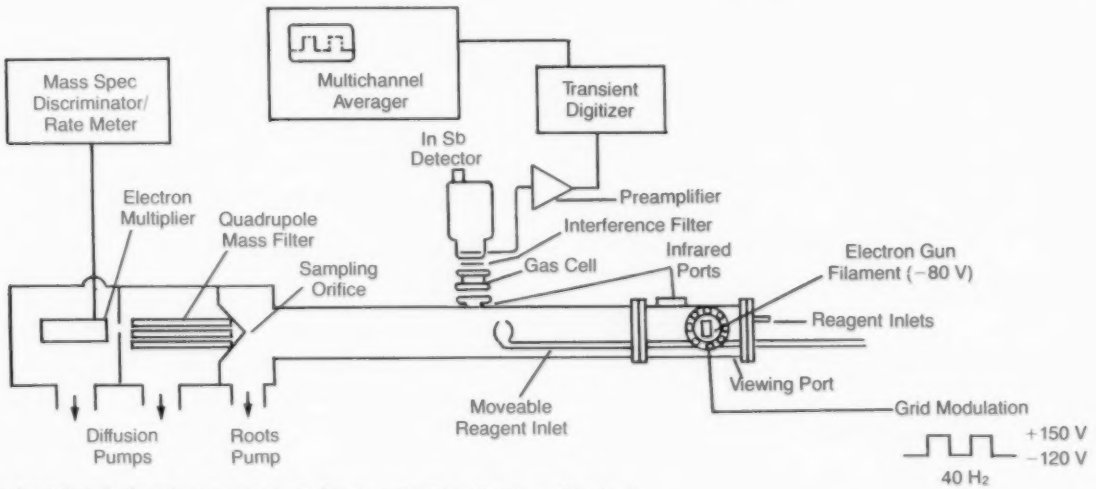

Figure 1—*Apparatus for infrared chemiluminescence studies in a flowing afterglow. The basic flowing afterglow apparatus consists of a Roots-type blower, a larger mechanical backing pump, flow tube, electron gun (the ionizer), and a quadrupole mass spectrometer 125 cm downstream from the ionizer. Helium enters through the ionizer housing, mixes with O_2 from the fixed reagent inlet, and carries the O_2 through the electron beam. O^- ions in the He flow react with CO from the moveable inlet. The InSb detector senses infrared emission from the vibrationally excited CO_2 reaction product.*

NEW UNDERSTANDING OF MOLECULAR STRUCTURE

A collaborative program has resulted in a deeper insight into the physics of core-excited molecular states.

David L. Ederer and Thomas B. Lucatorto, Optical Physics Division, A251 Physics Building, 301/921-2031.

The lithium dimer, Li_2, which is the second smallest molecule having a completed inner shell (LiH is the smallest) has been the subject of recent theoretical and experimental investigations. Its relative simplicity makes it interesting as a proving ground for modeling theories that can be applied to more complex systems. Besides being of fundamental interest, knowledge about the structure of Li_2 and other alkali dimers can have important practical applications. Some of these applications involve the development of dimer laser systems, the understanding of the bonding and surface properties of very small metal particles used in supported metal catalysts, and isotope separation for the production of enriched lithium. While the spectrum associated with outer electron excitations had previously been studied extensively, our present work was the first experimental and theoretical investigation of excitations involving core-excited states.

The lowest core-excited states in molecular lithium were observed in the absorption spectrum of Li vapor contained in a heat-pipe oven. Synchrotron radiation from the NBS Synchrotron Ultraviolet Radiation Facility was used as the background continuum to produce the absorption spectrum in the 20-22-nm wavelength interval which was dispersed and recorded with a three-meter grazing incidence spectograph. Densitometer traces of three photographic plates obtained for different optical depths are shown in figure 1. Since the vapor consists mostly of atoms (lithium molecules constitute only between 2 percent and 4 percent of the total vapor pressure) at the lowest column density the molecular features are too weak and only the lowest core excited

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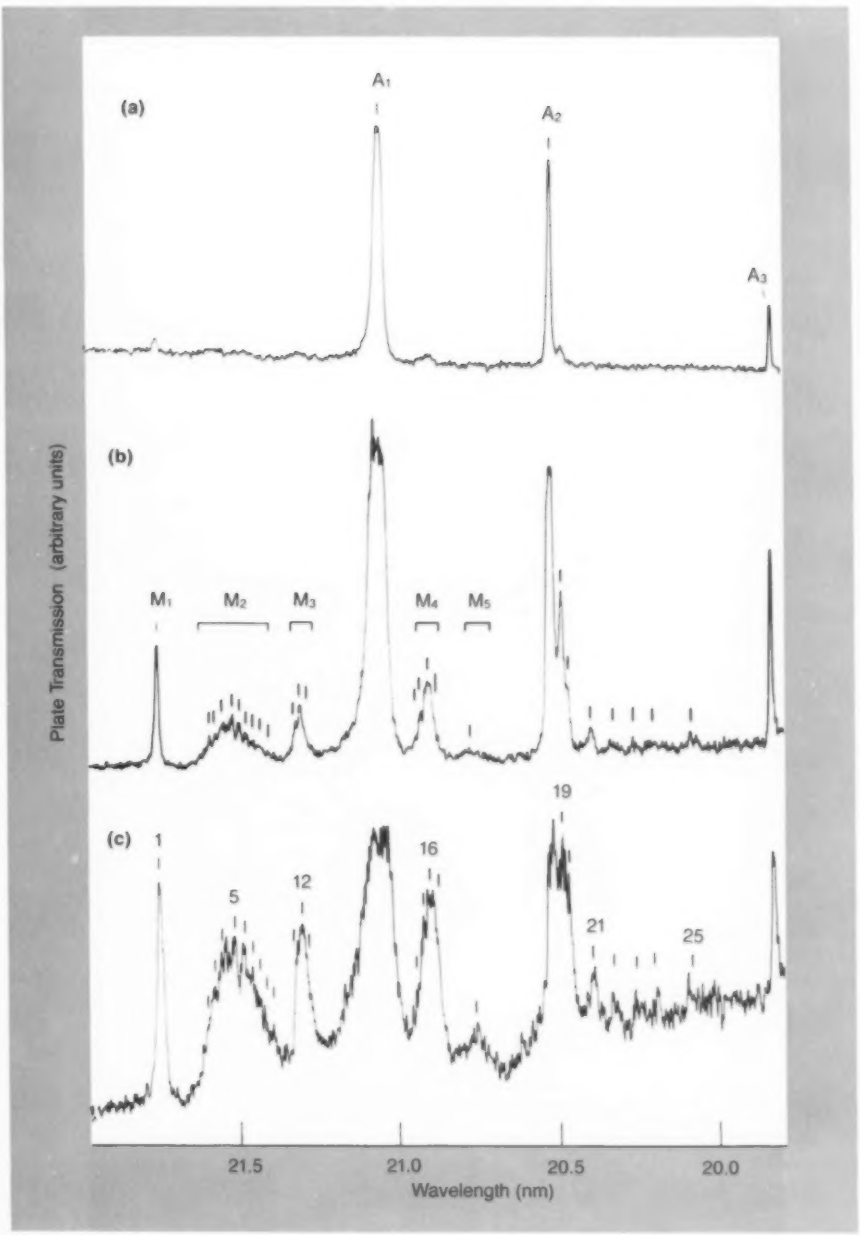


Figure 1—*Densitometer traces of three spectral plates showing Li vapor absorption in the region 22 → 19 nm. In trace (a), in which only the atomic features A_1, A_2, and A_3 are prominent, a total Li vapor pressure of 0.5 torr (65 Pa) was used. Trace (b), which shows the strongest molecular features (M_1–M_5), corresponds to a total pressure of 2.02 torr (270 Pa). Trace (c) represents the spectrum taken at 4.60 torr (610 Pa). The tic marks 1-25 in (b) and (c) indicate the energy position of all the observed molecular structure.*

atomic features A_1, A_2, and A_3 are observed in the spectrum shown in trace (a). The lowest energy molecular absorption transitions of the core electrons to the five lowest energy molecular levels (M_1-M_5) are observed at intermediate vapor densities in trace (b) and at high vapor densities in trace (c). The tic marks 1-25 indicate the energy position of all the observed molecular structure including the resolved vibrational structure in the electronic excitations M_2, M_3, and M_4.

Calculations of the excitations involving the outer electrons of molecular lithium can be carried out in a straightforward way because the core electron is not excited and no new electron pairs are formed. However, when the core electron is excited, the situation is complicated because the electrons become highly correlated and the customary formalism used to describe the spatial properties of the outer electrons must be replaced by a more elaborate computational method. These calculations for such highly excited states present a formidable problem. The core excited states lie in the continuum, and there is an infinitely large number of states with the same symmetry below them. Accounting for the various correlations between the excited electrons required the solution of a secular equation whose dimension was in the range of 2000-3000 for the core-hole states.

The results of the calculations indicate that four singly-excited empty orbitals are available in the valence shell above the occupied bonding orbital; consequently four strong transitions of the valence type are expected and observed (M_1—M_4). Through these computations, the weak structure M_5 shown in figure 1 is identified as a two electron excitation involving one of the core electrons and one of the bonding electrons. Furthermore the weak structure at shorter wavelengths (higher photon energies) has been shown to be due to different types of diffuse Rydberg molecular orbitals.

The present work is a good example of how several centers, each having a very specialized expertise, can collaborate to deal comprehensively with a very complicated problem. NBS contributed its knowledge of VUV spectroscopy with heat-pipe oven absorption cells done with a synchrotron VUV source. The group at Bonn are specialists in theoretical chemistry and have a unique capability to perform very difficult molecular orbital calculations. The laboratory at the University of Freiburg used its specialized capability to perform electron energy measurements on autoionized electrons to provide further information on the excited states useful in refining the theoretical description.

STANDARD REFERENCE MATERIAL ISSUED FOR PURITY OF DRINKING WATER

Public health scientists responsible for assuring the purity of drinking water in the nation's 250,000 public water systems will have an easier task as a result of a new Standard Reference Material.

SRM 1643, Trace Elements in Water, is intended for state environmental and public health scientists to evaluate the accuracy of trace element measurements in filtered and acidified fresh water. It will also be useful for calibrating instrumentation used in these determinations.

A recent National Academy of Sciences report (May 1977) expressed concern over safeguarding the purity of the nation's drinking water supplies. The Environmental Protection Agency (EPA) has established Interim Primary National Drinking Water Standards, which became effective in June 1977. These standards set maximum contaminant levels permitted for bacteria, maximum level of turbidity, and concentrations permitted for a number of organic and inorganic chemicals.

States are responsible for enforcing these standards. Accurate measurements are essential to reliable enforcement, and the new SRM will help give scientists a standard by which to assess the accuracy of their measurements.

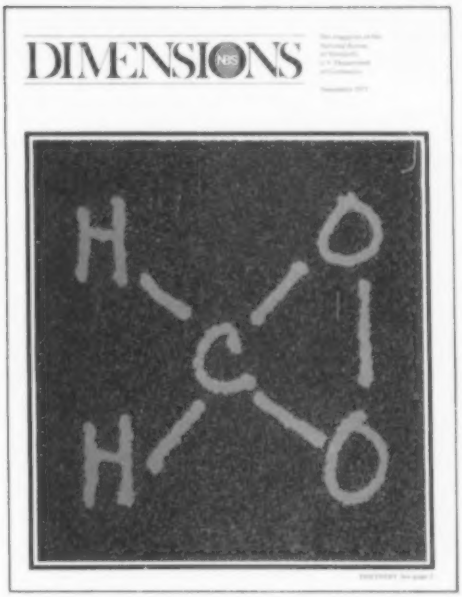
The new SRM was prepared using high purity water and 23 elements to simulate the elemental composition of natural fresh water. Seventeen elements have been certified in concentrations at the nanogram per gram (part per billion) level. They are silver, aluminum, arsenic, beryllium, cadmium, cobalt, chromium, copper, iron, molybenum, manganese, nickel, lead, selenium, strontium, vanadium, and zinc. The concentrations of two others, barium and mercury, are not certified, but are listed for information only. The remaining elements added were calcium, sodium, magnesium, and potassium. Nitric acid was added to stabilize the trace element composition.

EPA has set maximum contaminant levels for a number of the elements contained in the SRM including arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

SRM 1643 is the third in a series of NBS SRM's issued for the analysis of water. The first two were for mercury in water (SRM's 1641 and 1642).

SRM 1643 is issued as a unit of approximately 950 milliliters of solution in a polyethylene bottle, which is sealed inside an aluminized bag to maintain long-term stability and to prevent contamination. SRM 1643 may be purchased for $131 per unit from the Office of Standard Reference Materials, Chemistry B311, National Bureau of Standards, Washington, D.C. 20234.

Special for educators



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CONFERENCES

For general information on NBS Conferences, contact Sara Torrence, NBS Office of Information Activities, Washington, D.C. 20234, 301/921-2721.

LOW FREQUENCY ELECTRICAL MEASUREMENTS

The National Bureau of Standards will sponsor a 4-day seminar on the Accurate Measurement of Electrical Quantities and the Calibration of Electrical Standards at NBS Gaithersburg, MD, April 24-27, 1978.

The seminar will be devoted to the following general areas of concern in electrical measurements: classical electrical measurements, electronic electrical measurements, power and energy measurements, and data analysis and automation.

The lectures will have as a primary objective the presentation of acceptable measurement methodology for industrial and general standards laboratory application. The methods used at NBS and new approaches being studied will also be considered.

The program will consist of lectures, demonstrations in NBS Electricity Division laboratories and small group seminars discussing measurement problems of a more specific nature.

For further information contact: R. F. Dzuiba, Absolute Electrical Measurements Section, A247 Metrology Building, 301/921-3806.

IONIZING RADIATION MEASUREMENTS

The National Bureau of Standards will sponsor a 4-day seminar on the Measurement of Four Categories of Radiation: x-rays, electrons, neutrons, and radioactivity at NBS Gaithersburg, MD, May 9-12, 1978.

For each type of radiation, the principles of measurement and the important instruments and techniques will be discussed. Visits to NBS radiation and measurement laboratories will be included. For x-rays, emphasis will be placed on exposure and absorbed dose measurements. For electrons, the topics to be considered are measurements of beam current, charge, and energy. For neutrons, calibration of sources, thermal and fast neutron flux density and integral measurements of neutron fluence and spectra will be considered. In the area of radioactivity, topics such as counting techniques, statistics of counting, and calibration of sources will be covered.

For further information contact: E. H. Eisenhower, Center for Radiation Research, C229 Radiation Physics Building, 301/921-2551.

MICROCOMPUTER-BASED INSTRUMENTATION SYMPOSIUM

Current microcomputer capabilities and anticipated instrumentation applications will be discussed at a Symposium on Microcomputer-Based Instrumentation, to be held at the National Bureau of Standards, Gaithersburg, Maryland, on June 12-13, 1978.

Papers are solicited in each of four areas:

- Microcomputer Technology
- Applications to Scientific Instrumentation
- Microcomputer Interface Standards
- Applications to Industrial Process Control

Co-sponsored by NBS, the Institute of Electrical and Electronic Engineers (IEEE) Computer Society and the IEEE Group on Instrumentation and Measurement, the symposium's purposes include: Identifying and analyzing the current status and future trends in the application of microprocessor technology to instrumentation; documenting the extent, implications and current and future benefits of the use of microcomputers in measurement instruments; and identifying relevant standardization issues.

The June 12-13 gathering will be the first of a series of Symposia on Challenges in Science and Technology sponsored by Dr. Ernest Ambler, Acting Director of the National Bureau of Standards. The symposia will feature contributed and invited papers from within and outside NBS.

Questions on the symposia series and suggestions of topics should be directed to the general coordinator, Dr. Helmut Hellwig, Frequency and Time Standards Section, Room 4041, Boulder, CO 80302, 303/499-1000, ext. 3277.

CONFERENCE CALENDAR

***February 6-8**

PROCUREMENT: MANDATED PROGRAM UNDER RCRA (PL 94-580) and EPCA (PL 94-163) sponsored by NBS National Governor's Association; contact: Harvey Yakowitz, B160 Materials Building, 301/921-2343.

March 13-14

CONSTRUCTION DOCUMENTATION CONFERENCE; NBS, Gaithersburg, MD; sponsored by NBS, the Construction Specifications Institute, and the Guide Specifications Committee of the Federal Construction Council; contact: Roger Rensburger, B226 Technology Building, 301/921-3126.

March 22-24

28TH IEEE VEHICULAR TECHNOLOGY CONFERENCE; Denver, Colo; sponsored by NBS and the Institute of Electrical and Electronic Engineers; contact: John Shafer, NBS, Boulder, Colo., 303/499-1000, ext. 3185.

April 3-4

EMERGING PATTERNS IN AUTOMATIC IMAGERY PATTERN RECOGNITION; NBS, Gaithersburg, MD; sponsored by NBS and Electronic Industries Association; contact: Russell Kirsch, A317 Administration Building, 301/921-2337.

April 10-13

TRACE ORGANIC ANALYSIS; A NEW FRONTIER IN ANALYTICAL CHEMISTRY, NBS, Gaithersburg, MD; sponsored by NBS; contact: Harry S. Hertz, A105 Chemistry Building, 301/921-2153.

April 17-20

ACOUSTIC EMISSION WORKING GROUP MEETING, NBS, Gaithersburg, MD; sponsored by NBS and the AEWG; contact: John A. Simmons, B118 Materials Building, 301/921-3355.

April 23-26
AMERICAN NUCLEAR SOCIETY TOPICAL CONFERENCE ON COMPUTERS IN ACTIVATION ANALYSIS AND GAMMA RAY SPECTROSCOPY: Mayaguez, Puerto Rico; sponsored by NBS, American Chemical Society, American Nuclear Society, Energy Research and Development Administration, U. of Puerto Rico, Puerto Rico Nuclear Center; contact: B. S. Carpenter, B108 Reactor Building, 301/921-2167.

May 8-10
SYMPOSIUM ON REAL-TIME RADIOGRAPHIC IMAGING, NBS, Gaithersburg, MD; sponsored by NBS and the American Society for Testing and Materials; contact: Donald A. Garrett, A106 Reactor Building, 301/921-3634.

***May 9-12**
IONIZING RADIATION MEASUREMENT, NBS, Gaithersburg, MD; sponsored by NBS; contact: E. H. Eisenhower, C233 Radiation Physics Building, 301/921-2551

May 18
TRENDS AND APPLICATIONS SYMPOSIUM: DISTRIBUTED PROCESSING; NBS, Gaithersburg, MD; sponsored by NBS, IEEE Computer Society; contact: Shirley Watkins, B212 Technology Building, 301/921-2061.

***June 5-7**
3RD INTERNATIONAL SYMPOSIUM ON ULTRASONIC IMAGING AND TISSUE CHARACTERIZATION; NBS, Gaithersburg, MD; sponsored by NBS and National Institute of Health; contact: Melvin Linzer, A329 Materials Building, 301/921-2858.

June 12-13
MICROCOMPUTER BASED INSTRUMENTATION CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS, IEEE Computer Society; IEEE Group on Instrumentation and Measurement; contact: Bradford Smith, A130 Technology Building, 301/921-2381.

June 15
TOOLS FOR IMPROVED COMPUTING IN THE 80's, NBS Gaithersburg, MD; sponsored by NBS, Washington, D.C. Chapter of the Association for Computing Machinery; contact: Trotter Hardy, A367 Technology Building, 301/921-3491.

June 19-21
GAS KINETICS CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and the Committee on Chemical Kinetics, NBS, Committee on Chemical Kinetics of the National Academy of Sciences/National Research Council; contact: David Garvin, B154 Chemistry Building, 301/921-2771.

June 26-29
CONFERENCE ON PRECISION ELECTROMAGNETIC MEASUREMENTS, Ottawa, Ontario, Canada; sponsored by Institute of Electrical and Electronics Engineers, U.S. National Committee-International Union of Radio Science, and NBS; contact: Dee Belsher, NBS, Boulder, Colo.; 303/499-1000, ext. 3981.

July 17-20
FOURTH ANNUAL CONFERENCE OF THE AMERICAN ASSOCIATION FOR CRYSTAL GROWTH, NBS, Gaithersburg, MD; sponsored by NBS and AACG; contact: Robert L. Parker, B164 Materials Building, 301/921-2961.

***August 21-25**
INTERNATIONAL ASSOCIATION FOR THE PROPERTIES OF STEAM, NBS, Gaitherburg, MD; sponsored by NBS and IAPS; contact: Howard White A523 Administration Building, 301/921-2581.

***September 18-22**
CHARACTERIZATION OF HIGH TEMPERATURE GASES, NBS, Gaithersburg, MD; sponsored by NBS; contact: John Hastie, A307 Materials Building, 301/921-2859.

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PUBLICATIONS

SELECTED BIBLIOGRAPHY ON METRIC FOR BUILDING COMMUNITY

Metrication Problems in the Construction Codes and Standards Sector, Mahaffey, C. T., Nat. Bur. Stand. (U.S.), Tech. Note 915, 25 pages (June 1976) SD Catalog No. C13.46:915, 75 cents.
Recommended Practices for the Use of Metric (SI) Units in Building Design and Construction, Milton, H. J., Nat. Bur. Stand. (U.S.), Tech. Note 938, 47 pages (Apr. 1977) Stock No. 003-003-01761-2, $1.60.

With the United States changing to the metric system (SI), members of the construction industry—land planners, architects, manufacturers, suppliers, builders, and contractors—need to adapt many products and practices to metric units. A new publication from the National Bureau of Standards can assist the building community in locating definitive information on metrication and dimensional coordination.

The publication, Metrication and Dimensional Coordination—A Selected Bibliography, is intended to serve as an annotated guide to the pertinent literature. The two authors, Roy Clark and Candace Roat of NBS' Center for Building Technology in the Institute for Applied Technology, read and abstracted the available materials.

The following sources contained publications most relevant to metric issues:

- Department of Housing and Urban Development (HUD) Library:
- *Industrialization Forum index;*
- Catalog of the Graduate School of Design of Harvard University;
- National Bureau of Standards library;
- *Generic Modules Bibliography* of the Royal Architectural Institute of the Canada Committee on Generic Modules; and
- The collection of the NBS Metric Information Office (which governmental materials from the countries that are metric or are currently going metric.)

The references address questions such as cost and benefits of metric, education and information needs, design drawing and codes, suppliers, existing buildings, possible benefits of dimensional coordination and how it can be implemented, its effect on design and the technical aspects of building, and its application to particular types of construction.

HOURLY SOLAR RADIATION DATA FOR U.S. AND CANADA

Hourly Solar Radiation Data for Vertical and Horizontal Surfaces on Average Days in the United States and Canada, Kusuda, T., and Ishii, K., Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 96, 412 pages (Apr. 1977), Stock No. 003-003-01698-5, $4.65.

The National Bureau of Standards has published average day, hourly solar radiation data for 80 locations in the United States and Canada. The information will aid engineers and designers in determining the effects of solar radiation on a building and its heating and air conditioning systems throughout the year.

The majority of available solar radiation data for the United States and Canada are in the form of either monthly averages of daily total radiation on a horizontal surface or hourly values for cloudless days on horizontal, titled, and vertical surfaces. These existing data are not suitable for the building energy consumption analysis. NBS engineers Tamami Kusuda and Katsumi Ishii of the Center for Building Technology developed hourly solar radiation data for walls and roofs under "average" solar conditions, calculated from measured weather data over a long period of time. These data allow engineers to make estimates of the seasonal effect that incident solar radiation has on a building's heating and cooling load.

For each of the 80 locations, solar radiation was determined for south, southwest, west, north, northwest, east, and southeast and horizontal orientations. In additions, the NBS engineers computed a new parameter, "sol-air temperature for glass," which enables engineers and designers to calculate the net heat transfer through single or double glazing under average solar conditions for any of the eight primary vertical orientations or on a horizontal surface.

For example, on cold but sunny days, a south facing window would be losing heat by conduction and air infiltration while it is gaining solar heat. "This new parameter," explains engineer Kusuda, "allows one to determine the net benefit of the window." Kusuda says the data in the publication will also be of interest to designers of passive solar houses, which depend heavily on windows and orientation. The 412-page publication also contains the computer program for generating the average day hourly solar tables.

NBS PUBLICATION HELPS PUT WINDOWS TO WORK TO CONSERVE ENERGY

Window Design Strategies to Conserve Energy, Hastings, S. R., Crenshaw, R. W., Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 104, 209 pages (June 1977) Stock No. 003-003-01794-9, $3.75.

The selection and design of windows for buildings is an important factor in determining the building's energy consumption, according to a new study from the National Bureau of Standards.

The study, *Window Design Strategies to Conserve Energy,* shows that properly designed, located, and used windows can actually reduce energy costs in a building.

Poorly designed, they can be a large energy burden.

Research for the publication was sponsored by NBS, the Energy Research and Development Administration, and the Department of Housing and Urban Development within the framework of an NBS interdisciplinary research project on the energy-related performance of windows.

Written by S. Robert Hastings and Richard W. Crenshaw of the NBS Center for Building Technology, the publication provides 33 design strategies to make windows energy conserving. Each strategy is aimed at improving one or more of the six energy functions of windows. These functions are: providing winter solar heat, providing year round daylighting, rejecting summer solar heat, providing insulation and air tightness during periods of heating or air conditioning, and providing natural ventilation during temperature weather.

Opportunities for improving window performance are also divided into six groups: site, exterior appendages, frame, glazing, interior accessories, and building interior. The study looks at each of the 33 design strategies within these six groups and explains the physical phenomena responsible for each strategy's energy performance. The authors have also summarized the energy and non-energy disadvantages and advantages of each strategy and made cost approximations for implementing each strategy. Example installations and laboratory studies showing specific energy savings are also provided.

The illustrated, 209-page publication will be a valuable reference book for professional designers, lessees and owners of commercial space, home buyers and owners, window component manufacturers, and researchers.

Health and Safety

Urban Sciences, Inc., Digital Data Transmission Tests on Voice Channels, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-19, 63 pages (July 1977) Stock No. 003-003-01773-6, $2.10.

Electronic Technology

Goodman, A. M., *Semiconductor Measurement Technology: Suppression of Premature Dielectric Breakdown for High-Voltage Capacitance Measurement*, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-37, 27 pages (July 1977) Stock No. 003-003-01809-1, $1.30.

Jamba, D. M., *Semiconductor Measurement Technology: Some Aspects of Dose Measurement for Accurate Ion Implantation*, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-39, 44 pages (July 1977) Stock No. 003-003-01808, $1.60.

Schafft, H. A., Ed., *Semiconductor Measurement Technology: Reliability Technology for Cardiac Pacemakers II—A Workshop Report. Proceedings of a Workshop held at the National Bureau of Standards, Gaithersburug, Md., July 19-20, 1976*, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-42, 45 pages (Aug. 1977) Stock No. 003-003-01815-5, $1.60.

Energy Conservation and Production

Hastings, S. R., and Crenshaw, R. W., *Window Design Strategies to Conserve Energy*, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 104, 209 pages (June 1977) Stock No. 003-003-01794-9, $3.75.

Rossiter, W. J., Mathey, R. G., Jr., Burch, D. M., and Pierce, E. T., *Urea-Formaldehyde Based Foam Insulations: An Assessment of Their Properties and Performance*, Nat. Bur. Stand. (U.S.), Tech. Note 946, 92 pages (July 1977) Stock No. 003-003-01801-5, $2.30.

Fire Research

Parker, W. J., *An Investigation of the Fire Environment in the ASTM E 84 Tunnel Test*, Nat. Bur. Stand. (U.S.), Tech Note 945, 75 pages (Aug. 1977) Stock No. 003-003-01819-8, $2.20.

Fluids: Liquids

Robertson, B., and Baumgarten, G. P., *Evaluation of Automotive Fuel Flowmeters*, Nat. Bur. Stand. (U.S.), Tech. Note 943, 95 pages (June 1977) Stock No. 003-003-01799-0, $2.30.

Metrology: Physical Measurements

Cameron, J. M., Croarkin, M. C., and Raybold, R. C., *Designs for the Calibration of Standards of Mass*, Nat. Bur. Stand. (U.S.), Tech. Note 952, 64 pages (June 1977) Stock No. 003-003-01778-7, $2.10.

Geist, J., Lind, M. A., Schaefer, A. R., Zalewski, E. F., *Spectral Radiometry: A New Approach Based on Electro-Optics*, Nat. Bur. Stand. (U.S.), Tech. Note 954, 23 pages (July 1977) Stock No. 003-003-01835-8, $1.10.

Kamas, G., Ed., *Time and Frequency User's Manual*, Nat. Bur. Stand. (U.S.), Tech. Note 695, 217 pages (May 1977) Stock No. 003-003-01781-7, $2.80.

Lind, M. A., Zalewski, E. F., and Fowler, J. B., *The NBS Detector Response Transfer and Intercomparison Package: The Instrumentation*, Nat. Bur. Stand. (U.S.), Tech. Note 950, 23 pages (July 1977) Stock No. 003-003-01810-4, $1.10.

Nicodemus, F. E., Ed., *Self-Study Manual on Optical Radiation Measurements: Part I—Concepts, Chapter 6*, Nat. Bur. Stand. (U.S.), Tech. Note 910-3, 62 pages (June 1977) Stock No. 003-003-01785-0, $2.10.

Processing and Performance of Materials

Brown, B. F., *Stress Corrosion Cracking Control Measures*, Nat. Bur. Stand. (U.S.), Monogr. 156, 81 pages (June 1977) Stock No. 003-003-01674-8, $4.50.

Escalante, E., Iverson, W. P., Gerhold, W. F., Sanderson, B. T., and Alumbaugh, R. L., *Corrosion and Protection of Steel Piles in a Natural Seawater Environment*, Nat. Bur. Stand. (U.S.), Monogr. 158, 42 pages (June 1977) Stock No. 003-003-01788-4, $1.60.

Standard Reference Data

Goldberg, R. N., Staples, B. R., Nuttal, R. L., and Arbuckle, R., *A Bibliography of Sources of Experimental Data Leading to Activity or Osmotic Coefficients for Polyvalent Electrolytes in Aqueous Solution*, Nat. Bur. Stand. (U.S.), Spec. Publ. 485, 53 pages (July 1977) Stock No. 003-003-01812-1, $2.

Standard Reference Materials

Rossmassler, S. A., Ed., *Critical Evaluation of Data in the Physical Sciences—A Status Report of the National Standard Reference Data System, January 1977*, Nat. Bur. Stand. (U.S.), Tech Note 947, 84 pages (May 1977) Stock No. 003-003-01776-1, $2.20.

Thermodynamics and Chemical Kinetics

Nuttall, R. L., and Armstrong, G. T., *Estimation of Net Enthalpies of Combustion of Some Aviation Fuels Expressed in the International System of Units (SI)*, Nat. Bur. Stand. (U.S.), Tech. Note 937, 63 pages (Apr. 1977) Stock No. 003-003-01763-9, $1.30.

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NEWS BRIEFS

AMBLER NOMINATED AS DIRECTOR OF NBS. President Carter has nominated Dr. Ernest Ambler to be the eighth director of the National Bureau of Standards. Ambler has served with the federal government since 1953 when he joined NBS. In 1973 he was appointed deputy director of NBS and has been serving as acting director since the resignation of Dr. Richard W. Roberts in June 1975. Confirmation hearings were held on December 14 and the full Senate is expected to take action on the nomination when it reconvenes this month.

INCREASED INTEREST IN SOLAR ENERGY. Use of solar energy received a big boost by the states between 1974 and 1976, according to a new survey by NBS. By the end of 1976, 35 states had passed laws or resolutions encouraging or expediting the adoption of solar energy systems in buildings. The survey, State Solar Energy Legislation of 1976: A Review of Statutes Relating to Buildings was undertaken by the NBS Center for Building Technology with funding from the Department of Energy and the Department of Housing and Urban Development. The survey can be ordered for $10.75 a copy from the National Technical Information Service, Springfield, VA 22151 (Use NTIS Number PB 273899).

GETTING THE LEAD OUT. The concentration of lead in the air at indoor firing ranges can reach hazardous levels. In a study conducted by the National Bureau of Standards, use of ammunition containing soft-point projectiles and a special lead-free primer reduced particulate lead emission from guns by more than 99 percent. The jacketed projectile is available commercially. The non-lead primer is still experimental. A report on the study, called The Reduction of Airborne Lead in Indoor Firing Ranges by Using Modified Ammunition, is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Cost is $1.20 a copy. Order by Stock No. 003-003-01021-0.

HANDY GUIDE FOR COMPUTER USERS. NBS has published a concise rundown on directories of software programs available from private organizations, academic institutions, and government agencies. So no one need "re-invent the wheel," Special Publication 500-22, Guide to Computer Program Directories, refers users to sources for programs already developed, tested, and in use. It is based on the NBS collection of catalogs or directories for software that is either proprietary or in the public domain. The Guide (Stock No. 003-003-01867-8, $3.25 a copy) is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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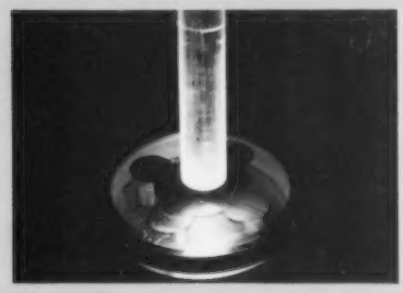

You won't find piezoelectric polymers discussed in the Encylopedia Britannica. Their use in piezoelectric devices is too new. Yet these materials are finding their way into an increasing number of products and processes from stereo components to the printing of currency. Read about piezoelectric polymers in the next issue of DIMENSIONS/NBS.

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